A. PROJECT MANAGEMENT REQUIREMENTS

A1 Title and Approval Sheet

Document Title:	2017-2021 Volunteer River Assessment Program Quality Assurance Project Plan
Lead Organization:	NH Department of Environmental Services Water Division-Watershed Management Bureau
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Preparation Date:	May 17, 2017
USEPA RFA Control Number	RFA17083

	Signature/Date
Program Manager:	Ted Walsh 10/23/17 Ted Walsh, NHDES
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NHHHS Laboratory Quality Assurance Manager:	10-24-17 Rachel Rainey, NH Public Health Laboratory
NHDES Quality Assurance Manager:	11/3/17 Vincent Perelli, NHDES
USEPA QA Officer:	11/14/17 Robert Reinhart, US EPA Region 1
USEPA Technical Lead:	11/14/17 Diane Switzer, US EPA Region 1
USEPA Project Officer:	11/14/17 Jennifer Brady, US EPA Region 1

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EPA-NE QAPP Worksheet #2

1. Identify guidance used to prepare QAPP: EPA Requirements for Quality Assurance Project Plans EPA QA/R-5, Final March 2001

2. Identify EPA Program: No specific EPA program but data are applicable to Clean Water Act, Section 303(d) and 305(b), Surface Water Program

3. Identify approval entity: EPA-NE, State, or other: EPA-New England and NHDES

4. Indicate whether the QAPP is a generic program QAPP or a project specific QAPP. (underline one)

5. List dates of scoping meetings that were held: N/A

6. List title of QAPP documents and approval dates written for previous site work, if applicable:

Title: NH Volunteer River Assessment Program Quality Assurance Project Plan Approved 09/09/03

7. List organizational partners (stakeholders) and connection with EPA and/or State:

EPA-NE New England Regional Laboratory
NHDES, Water Division, Water Quality Planning Section and Biology Section
Volunteer Monitors throughout New Hampshire

8. List data users:

EPA, NHDES, Public and private sectors, volunteer monitors throughout New Hampshire
U.S. Environmental Protection Agency

9. If any required QAPP Elements (1-20), Worksheets and/or Required Information are not applicable the project, then circle the omitted QAPP Elements, Worksheets and Required Information on the attached Table. Provide an explanation for their exclusion below:

All QAPP elements are included in the Volunteer River Assessment Program QAPP.

Required EPA QA/R-5 QAPP Elements	Required EPA-NE QAPP Elements and Corresponding EPA-NE QAPP Sections	EPA-NE QAPP Worksheet #	Required Information
Project Management and Objectives			
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A5	5.0 Project Planning/Project Definition 5.1 Project Planning Meetings 5.2 Problem Definition/Site History and Background	8a 8b	-Project Scoping Meeting Attendance Sheet with Agenda and other Project Planning Meeting Documentation -Problem Definition/Site History and Background -EPA-NE DQO Summary Form -Site Maps (historical and present)
A6	6.0 Project Description and Schedule 6.1 Project Overview 6.2 Project Schedule	9a 9b 9c 9d 10	-Project Description -Contaminants of Concern and Other Target Analytes Table -Field and Quality Control Sample Summary Table -Analytical Services Table -System Designs -Project Schedule Timeline Table
A7	7.0 Project Quality Objectives and Measurement Performance Criteria 7.1 Project Quality Objectives 7.2 Measurement Performance Criteria	11a 11b	-Project Quality Objectives/Decision Statements -Measurement Performance Criteria Table
Measurement/Data Acquisition			
B1	8.0 Sampling Process Design 8.1 Sampling Design Rationale	12a 12b	-Sampling Design and Rationale -Sampling Locations, Sampling and Analysis Method/SOP Requirements Table -Sample Location Map

Required EPA QA/R-5 QAPP Elements	Required EPA-NE QAPP Elements and Corresponding EPA-NE QAPP Sections	EPA-NE QAPP Worksheet #	Required Information
B2, B6, B7, B8	9.0 Sampling Procedures and Requirements 9.1 Sampling Procedures 9.2 Sampling SOP Modifications 9.3 Cleaning and Decontamination of Equipment/Sample Containers 9.4 Field Equipment Calibration 9.5 Field Equipment Maintenance, Testing and Inspection Requirements 9.6Inspection and Acceptance Requirements for Supplies/Sample Containers	13 12b 14 15	-Sampling SOPs -Project Sampling SOP Reference Table -Sampling Container, Volumes and Preservation Table -Field Sampling Equipment Calibration Table -Cleaning and Decontamination SOPs -Field Equipment Maintenance, Testing and Inspection Table
B3	10.0 Sample Handling, Tracking and Custody Requirements 10.1 Sample Collection Documentation 10.1.1 Field Notes 10.1.2 Field Documentation Management System 10.2 Sample Handling and Tracking System 10.3 Sample Custody	16	-Sample Handling, Tracking and Custody SOPs -Sample Handling Flow Diagram -Sample Container Label (Sample Tag) -Chain-of-Custody Form and Seal
B4, B6, B7, B8	11.0 Field Analytical Method Requirements 11.1 Field Analytical Methods and SOPs 11.2 Field Analytical Method/SOP Modifications 11.3 Field Analytical Instrument Calibration 11.4 Field Analytical Instrument/ Equipment Maintenance, Testing and Inspection Requirements 11.5 Field Analytical Inspection and Acceptance Requirements for Supplies	17 18 19	-Field Analytical Methods/SOPs -Field Analytical Method/SOP Reference Table -Field Analytical Instrument Calibration Table -Field Analytical Instrument/Equipment Maintenance, Testing and Inspection Table

Required EPA QA/R-5 QAPP Elements	Required EPA-NE QAPP Elements and Corresponding EPA-NE QAPP Sections	EPA-NE QAPP Worksheet #	Required Information
B4, B6, B7, B8	12.0 Fixed Laboratory Analytical Method Requirements 12.1 Fixed Laboratory Analytical Methods and SOPs 12.2 Fixed Laboratory Analytical Method/SOP Modifications 12.3 Fixed Laboratory Instrument Calibration 12.4 Fixed Laboratory Instrument/ Equipment Maintenance, Testing and Inspection Requirements 12.5 Fixed Laboratory Inspection and Acceptance Requirements for Supplies	 20 21	-Fixed Laboratory Analytical Methods/SOPs -Fixed Laboratory Analytical Method/SOP Reference Table -Fixed Laboratory Instrument Maintenance and Calibration Table
B5	13.0 Quality Control Requirements 13.1 Sampling Quality Control 13.2 Analytical Quality Control 13.2.1 Field Analytical QC 13.2.2 Fixed Laboratory QC	 22a 22b 23a 23b 24a 24b	Sampling - Field Sampling QC Table - Field Sampling QC Table cont. Analytical - Field Analytical QC Table - Field Analytical QC Table cont. - Field Screening/Confirmatory Analysis Decision Tree - Fixed Laboratory Analytical QC Sample Table - Fixed Laboratory Analytical QC Sample Table cont.
B9	14.0 Data Acquisition Requirements	25	-Non-Direct Measurements Criteria and Limitations Table
A9, B10	15.0 Documentation, Records and Data Management 15.1 Project Documentation and Records 15.2 Field Analysis Data Package Deliverables 15.3 Fixed Laboratory Data Package Deliverables 15.4 Data Reporting Formats 15.5 Data Handling and Management 15.6 Data Tracking and Control	26	-Project Documentation and Records Table -Data Management SOPs

Required EPA QA/R-5 QAPP Elements	Required EPA-NE QAPP Elements and Corresponding EPA-NE QAPP Sections	EPA-NE QAPP Worksheet #	Required Information
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C2	17.0 QA Management Reports	28	-QA Management Reports Table
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D2	19.0 Verification and Validation Procedures	29a 29b 29c	-Data Evaluation Process -Data Validation Summary Table -Data Validation Modifications
D3	20.0 Data Usability/Reconciliation with Project Quality Objectives	30	-Data Usability Assessment

A3 Distribution List

Table 1 shows the individuals and their respective agency affiliations that will receive the approved QAPP, the QAPP revisions, and any amendments.

Table 1. QAPP Distribution List

QAPP Recipient Name	Title	Organization	Telephone Number and Email Address
Gregg Comstock	Water Quality Planning Section Supervisor	NHDES	(603) 271-2983 Gregg.Costock@des.nh.gov
Ted Walsh	Program Manager	NHDES	(603) 271-2083 Ted.Walsh@des.nh.gov
Amanda Bridge	Program Coordinator	NHDES	(603) 271-2949 Amanda.Bridge@des.nh.gov
Margaret Foss	Program QA Officer	NHDES	(603) 271-0699 Margaret.Foss@des.nh.gov
Vincent Perelli	NHDES Quality Assurance Manager	NHDES	(603) 271-8989 Vincent.Perelli@des.nh.gov
Rachel Rainey	Laboratory QA Manager	NHDES	(603) 271-2993 Rachel.Rainey@des.nh.gov
Nora Conlon	USEPA Quality Assurance Officer	EPA - NE	(617) 918-8335 Conlon.Nora@epa.gov

A4 Project Organization

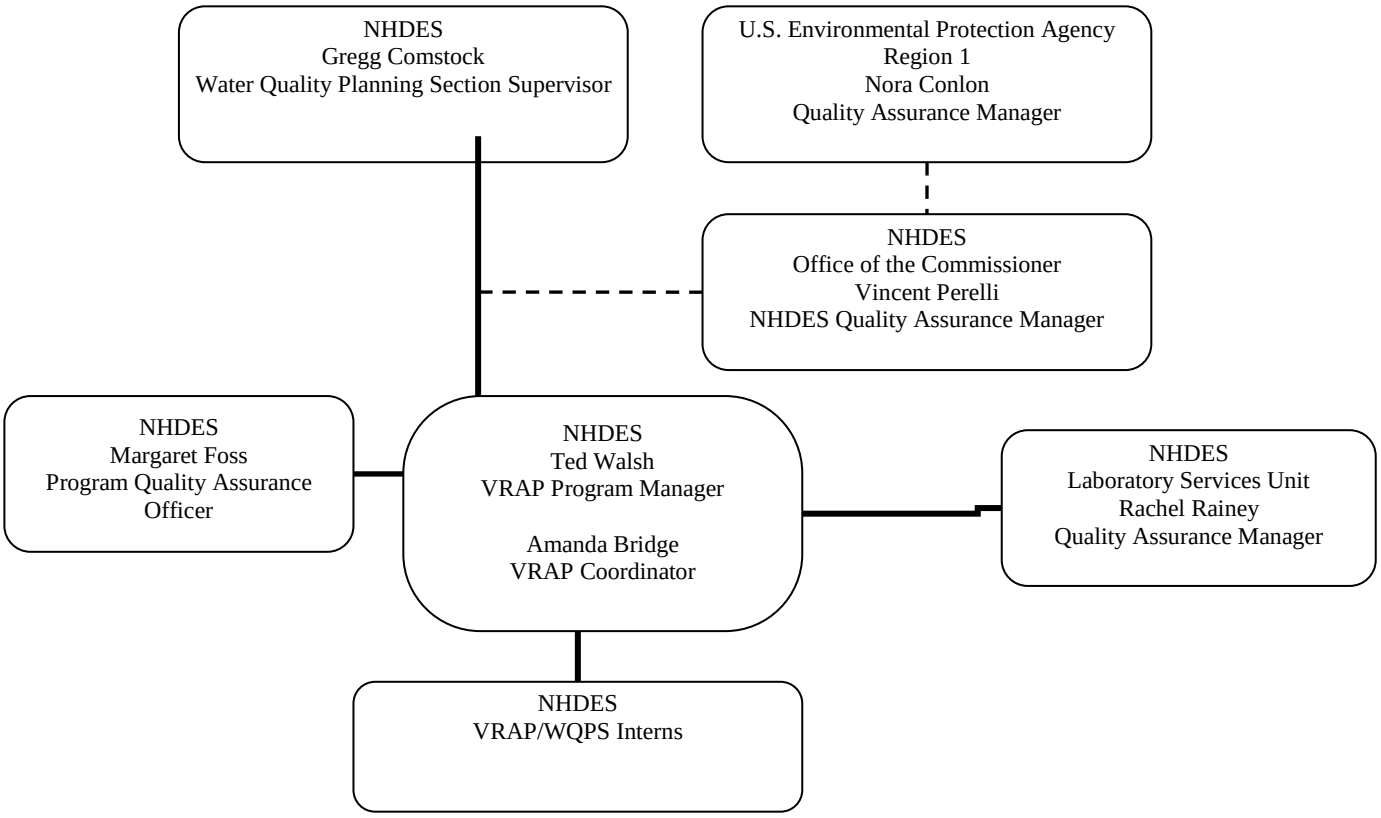
This section identifies the organizations and key personnel participating in the project and describes their specific roles, responsibilities, and qualifications. This section also explains communication pathways.

A4.1 Project Organization Description and Chart

The Volunteer River Assessment Program (VRAP) is administered through the NHDES Watershed Management Bureau (WMB) by staff of the Water Quality Planning Section (WQPS) (Figure 1). VRAP staff collaborates with other WMB staff and volunteer groups to design and implement annual water quality sampling and analysis plans, which include sampling station locations, sampling frequency/duration and water quality parameters. The Program Manager supervises program staff and manages plans, develops, and implements program policies to generate high quality volunteer water quality data for waterbody assessments. The Program Coordinator is responsible for coordinating and planning the daily duties necessary for VRAP to successfully serve both NHDES and the public, ensure program efficiency, and ensure the volunteers are provided with the equipment, supplies, and technical assistance needed to collect high quality data. The Program QA Officer collaborates with the Program Manager and WMB staff to implement the QAPP and ensure that data generated by VRAP is useable in 305(b)/303(d) reporting. NH DHHS Public Health Laboratory personnel are responsible for analyzing water samples. Rachel Rainey, NH DHHS Public Health Laboratory, is the Laboratory QA Manager and is responsible for reviewing and revising laboratory-related elements of the QAPP. The Laboratory QA Manager also oversees the implementation of the QAPP in the laboratory. Margaret Foss is the VRAP QA Officer. Scott Ashley is the QA Coordinator for the NHDES JCLC and the satellite laboratories.

The VRAP staff with the assistance of other trained WMB staff, train all VRAP participants in proper water sampling, field analysis techniques, QA/QC procedures, submission of water quality data, and field documentation procedures. Volunteers are usually affiliated with a local watershed group, Local Advisory Committees (LACs) under the Rivers Management and Protection Program (RMPP), or a municipal entity (Conservation Commission) and are responsible for field data collection and ensuring that all QA/QC requirements are adhered to. VRAP staff and Water Quality Planning Section staff are responsible for entering volunteer data into the NHDES Environmental Monitoring Database (EMD) which is WQX compatible.

Figure 1. Organizational chart for NHDES Volunteer River Assessment Program



A5 Program Description/Background

The Volunteer River Assessment Program (VRAP) was initiated in 1998 to promote awareness and education of the importance of maintaining water quality in New Hampshire's rivers and streams. VRAP aims to educate people about river and stream water quality and ecology and to improve water quality monitoring coverage for the protection of water resources.

The rivers and streams of the State of New Hampshire receive drainage from multiple land use watersheds, which create diverse ambient surface water quality conditions throughout the state. These conditions have varying implications for the support of designated uses such as primary contact recreation and aquatic life use. The ability of rivers and streams to support designated uses is measured through the VRAP program relative to New Hampshire's surface water quality standards. Recent and historic data collected under the VRAP program and other NHDES water monitoring programs have depicted a wide range of water quality conditions relative to physical, chemical, and biological parameters such as water temperature, dissolved oxygen, pH, and *Escherichia coli* (*E. coli*) bacteria. Water quality is spatially and temporally dynamic and generally reflects land and water management practices.

The VRAP program is primarily a data procurement mechanism to determine whether rivers or streams are impaired or potentially impaired, based on legislative surface water quality standards and designated uses (e.g., swimming, fishing, and aquatic life support). Data collected through VRAP is used to develop the federal 303(d) list and 305(b) report, from which impaired or potentially impaired waters are targeted for additional, detailed study. Over 20% of the surface water quality assessments of riverine assessment

units included in the 2016 303(b) report were provided by the VRAP program. In 2016, this data contributed to the assessment of 2,558 miles of rivers and streams on 465 riverine assessment units.

VRAP data is also used by NHDES to generate annual water quality reports and for educational and outreach purposes. The establishment of long-term water quality monitoring programs allows for an understanding of the river's dynamics, or variations on a station-by-station and year-to-year basis. Data generated by VRAP groups serves as a baseline from which to determine any water pollution problems in the river and/or watershed. VRAP data is also intended to assist participating groups along with local, state, and federal governments in restoration efforts, effective financial resource allocation, and watershed planning.

A6 Project/Program Task Descriptions

A6.1 Project (Program) Overview

The purpose of VRAP is to assess the physical, chemical and biological characteristics of the rivers and streams throughout the state. Environmental results are measured by making comparisons to water quality standards and by making comparisons to established means and ranges of water quality throughout the state. The data collected by VRAP is used by NHDES for water quality assessment, education, and reporting purposes. The data are used by volunteer monitors for educational purposes, for guiding management and restoration efforts, and also for local watershed management.

VRAP staff assists each VRAP group in developing an annual Sampling and Analysis Plan (SAP) (Appendix C-7) and selecting monitoring stations. Sampling stations are generally selected to provide an overview of the ambient water quality conditions for the waterbodies of concern for a particular VRAP group. Additional monitoring stations are selected based on suspicion of potential pollution sources, to provide baseline data prior to the initiation of development within the watershed, and to gather more detailed information related to a specific project which the VRAP group is engaged in. Potentially or confirmed impaired waters are identified and subsequently placed on the 305(d) list, with the purpose of increasing the sampling frequency to confirm impairment status or to determine potential pollutant sources. The VRAP program includes several components: (1) planning and design; (2) field data collection; (3) laboratory analysis; and (4) data management.

A6.2 Project/Program Sampling Tasks

Sampling tasks: Analytical parameters included in VRAP are shown in Table 2, and their applicability is justified relative to the specific uses of a waterway. For example, elevated levels of *E. coli* bacteria present a public health concern when a particular waterbody is used for primary contact recreation such as swimming. Depressed dissolved oxygen and pH, high/low water temperature, and elevated turbidity levels present an environmental concern for the development and/or maintenance of fish and benthic macroinvertebrate communities.

In some cases, water quality parameters other than those listed in Table 2 may be sampled during any monitoring year of this five-year QAPP. For example, additional water quality data may be needed to support the development of water quality models. As such, water samples analyzed for parameters other than those described in Table 2 are collected according to the sampling SOP described in Appendix A-1. Further, parameter-specific instructions are followed, when necessary, in accordance with the requirements of the NHDES JCLC or Standard Methods for the Examination of Water and Wastewater. Similarly, water sample analyses in the laboratory are conducted according to established SOPs and

respective laboratory measurement performance criteria (Appendix B). Any parameters and their corresponding SOPs and measurement performance criteria, added or subtracted from VRAP during any given year are documented in annual Sampling and Analysis Plans (SAPs) and the annual VRAP QA/QC report.

Water samples are collected throughout the year although the majority of samples are collected from April through October, typically under low-flow, high temperature conditions, as these conditions are assumed to represent the limiting conditions of most rivers and streams during the year. In addition, rivers and streams receive the greatest recreational use during this period. When possible, the number of samples collected is based on statistical guidance for determining whether rivers and streams are impaired. However, each VRAP group varies in terms of the number of volunteers available and thus SAPs are developed that are suitable to the resources of individual groups. Sampling methods include the use of field instrumentation and glass/plastic water sample bottles; storage bottles are appropriately labeled with station name, date and time of sample collection, parameter of interest, and initials of field crew. All sampling information is documented on field data sheets at the time of sampling.

Analysis tasks: Throughout the monitoring period, dissolved oxygen, water temperature, pH, specific conductance, turbidity, and discharge are measured in the field, whereas water samples are analyzed in the laboratory for nutrients, metals, and bacteria, etc. (Table 2). Laboratory analytical services are provided primarily by the State of New Hampshire, Department of Health and Human Services Public Health Laboratory. There are some VRAP groups that use outside accredited laboratories. The use of these outside laboratories is subject to approval by the VRAP Program Manager. Some VRAP groups have developed partnerships with local wastewater treatment facilities that provide in-kind laboratory services primarily for *E.coli* analysis. Standard operating procedures (SOPs) for all field tasks are provided in Appendix A and laboratory analysis tasks in Appendix B.

Table 2. Surface water analytical services table

Typical Analytes	Laboratory Contact or Instrument and Person Responsible
LABORATORY ANALYSIS	
Alkalinity Aluminum (Al) Ammonia (NH_3) Biochemical Oxygen Demand: (five-day) Calcium (Ca) Chloride (Cl) Copper (Cu) Dissolved Ortho Phosphorus (DOP) *Escherichia. Coli (E. coli)* *Enterococcus* Hardness Lead (Pb) Magnesium (Mg) Nitrate+Nitrite (NO_3+NO_2) Potassium (K) Sodium (Na) Sulfate (SO_4) Total Kjeldahl Nitrogen (TKN) Total Organic Carbon (TOC) Total Phosphorus (TP) Total Solids (TS) Total Suspended Solids (TSS) Zinc (Zn)	NH Department of Health and Human Services Public Health Laboratory 29 Hazen Drive, Concord NH 03301 Rachel Rainey, (603) 271-2993
Alkalinity Chlorophyll-*a* Chloride (Cl)	NHDES Jody Connor Limnology Center 29 Hazen Drive, Concord NH 03301 David Neils, (603) 271-8865
Escherichia. Coli (E. coli)	Individual Wastewater Treatment Laboratories
FIELD ANALYSIS	
Dissolved oxygen pH Specific Conductance Turbidity Water Temperature Water Level Velocity/Discharge (Flow)	NHDES Watershed Management Bureau 29 Hazen Drive, Concord, NH 03301 Ted Walsh, (603) 271-2083 Amanda Bridge, (603) 271-2949

Quality control tasks: Quality control tasks consist of instrument calibration, replicate sample collection, equipment blank sample collection, sample bottle preparation, and duplicate laboratory analyses. Field water quality instrumentation and laboratory analytical instrumentation are calibrated according to manufacturer's specifications prior to use. Sample bottles are appropriately prepared (e.g., rinsed, sterilized, preserved, etc.) prior to sample collection. Replicate samples for laboratory analytes are collected and analyzed at a minimum frequency of 10% and once per sampling event or 10% if greater

than 10 stations sampled for field measurements. A complete description of quality control tasks is included in Section B5.

Secondary data: Data collected through the Trend, Synoptic and Ambient River Monitoring Programs and the Volunteer Lake Assessment Program (VLAP) may serve as secondary data for VRAP. The data may be used to determine the need for additional sampling stations. For example, if data from VLAP show potential water quality problems at the outlet stream to a particular lake, VRAP may target those stations for additional data collection if a VRAP group is active in that watershed..

Data management tasks: Data management consists of handling and storage of field data sheets and electronic records. Field and laboratory data are written on field data sheets and laboratory bench books at the time of sampling and analysis, respectively. All written records are retained in the WQPS office and the laboratory. All data are entered and permanently stored in the NHDES Environmental Monitoring Database (EMD) for subsequent use and analysis. Data management is discussed in further detail in Sections B3 and B10 of this QAPP.

Documentation and records: Documentation and records include this QAPP, standard operating procedures, sampling and analysis plans, annual VRAP self-audit reports, field technical systems audits, field data, laboratory data, and training forms. With the exception of laboratory documentation and records, which are retained by the NH DHHS Public Health Laboratory, all documentation and records are retained at NHDES. A complete description of documentation and records is included in Section C.

Assessment/Audit tasks: Assessment and audit tasks consist of annual VRAP self-audits and individual VRAP group field audits. The self-audits are conducted under the purview of the NHDES Quality Management Plan (QMP) and this QAPP after the conclusion of each sampling year. The self-audit includes a description of QAPP inconsistencies. All data collected through VRAP is assessed for precision and accuracy according to the measurement performance criteria described in Section A7 of this QAPP.

Data verification and validation tasks: Data verification and validation tasks for field data and laboratory results occur throughout the sampling period, including review of replicate samples, critical ranges, and consistency of spiked samples (laboratory only). The data are also screened for outliers, with outliers being highlighted and examined to determine the origin of the deviation. A complete Description of data verification and validation tasks and procedures are included in Section D of this QAPP.

Data usability tasks: Data usability will be based on data verification and validation. Section D of this document discusses more data usability and assessment tasks.

A6.3 Project Timeline

Several VRAP activities and corresponding deliverables are completed throughout the year (Table 3). The VRAP program typically initiates data collection in April of each calendar year. The deliverable for each specific year is a data set used to determine whether a river or stream is impaired or potentially impaired, based on surface water quality standards, designated use support and an individual water quality report for each volunteer group based on data collected by the group.

Unforeseen delays may occur, but will not compromise the quality of the data. Data quantity may be reduced as a result of extreme weather events (*e.g.*, severe thunderstorms or floods) that may create unsafe working conditions and therefore delay data collection. Any delays associated with data verification (*e.g.*, laboratory and/or computer complications) are reported to the Program Manager. The Program Manager reports delays to WQPS and Data Management staff, as necessary, and the schedule for data reporting is revised accordingly.

Table 3. Project Schedule Timeline

Activity	Dates For Annual Activities		Deliverable	Deliverable Due Date
	Anticipated Date(s) of Initiation	Anticipated Date(s) of Completion		
Plan Volunteer River Assessment Program	January 1	April 30	Annual Work Plan	May 15
Revise QAPP and SOPs, as necessary	February 1	April 15	QAPP Document and SOPs	April 15
Inventory supplies and equipment	February 1	March 31	Supply/equipment list	March 31
Test water quality equipment	February 1	March 31	Equipment tested	March 31
Conduct training sessions for volunteer monitors and distribute water quality sampling equipment	April 1	June 30	Training sessions	June 30
Receive and review water quality data	April 1	December 31	Water quality data	December 31
Input data to water quality database	June 1	December 31	Data input	December 31
Conduct field Audits	June 1	September 30	Completed Field Audits	September 30
Receive water quality sampling equipment	October 1	December 31	Equipment received	December 31
Synthesize data and create water quality reports	September 30	February 15 after sampling year	Water quality reports	February 15 after sampling year
Perform annual VRAP audit	January 1 after sampling year	February 15 after sampling year	Program audit memorandum	February 15 after sampling year

A7 Quality Objectives and Criteria

The quality of the entire VRAP data set is assessed after the conclusion of the sampling year according to the measurement performance criteria shown in Table 4. However, data quality is also monitored throughout the sampling year to determine the need for corrective actions during field sampling. Precision and accuracy are the two primary criteria used in the assessment.

A7. 1 Precision

Precision for all parameters is based on a comparison between an original sample/measurement and a corresponding replicate sample/measurement. Precision is determined through relative percent difference (RPD) and absolute difference calculations, which vary according to parameter. RPD is calculated according to Equation 1, below. The calculations are subsequently compared to the parameter-specific RPDs described in Table 4.

The frequency of field replicates is one for each volunteer sampling event or every 10 samples (*i.e.*, 10%) if more than 10 stations are sampled by a volunteer team on one day, whereas the frequency for laboratory duplicates varies according to analyte (*e.g.*, replicate for every 10 total phosphorus samples) (Tables 16 through 39, B5).

(1)
$$RPD = \frac{|x_1 - x_2|}{\frac{x_1 + x_2}{2}} \times 100\%$$

where x_1 is the original sample concentration
x_2 is the replicate sample concentration

Table 4. Measurement Performance Criteria for Chemical and Physical Water Samples

Analytical Parameter	Analytical Method/ SOP Reference	Precision[a]	Accuracy[a]	Sensitivity[a]	QC Sample and/or Activity Used to Assess Measurement Performance
PARAMETERS MEAUSRED IN THE FIELD					
Dissolved Oxygen	Appendix A-1; A-3, A-5, A-7	**Field Replicate** RPD ≤ 10% or ABS ≤ 0.4 mg/l or ≤ 4%			Measurement replicates
			Handheld Meter ±2.0% of calibration saturation absolute value one minute after altitude and/or barometric compensated calibration **Multiparameter Datalogger** After Calibration: ±0.2 mg/L from Oxygen Solubility in Water Value based on concurrent water temperature and barometric conditions Post Deployment :± 0.5 mg/L from Oxygen Solubility in Water Value based on concurrent water temperature and barometric conditions. If the post deployment value exceeds :± 0.5 mg/L the data may still be deemed valid by a qualified water quality specialist after examining the data and comparing it to simultaneous data collected with handheld meters. Handheld measurements are considered replicates and subject to the precision requirements listed in this table.		Initial Calibration Values Post Deployment Checks Comparison to Handheld Meters

Analytical Parameter	Analytical Method/ SOP Reference	Precision[a]	Accuracy[a]	Sensitivity[a]	QC Sample and/or Activity Used to Assess Measurement Performance
pH	Appendix A-1; A-3, A-5, A-7	**Field Replicate** ABS ≤ 0.3 std units			Measurement replicates
			Handheld Meter Calibration slope: 95% - 105% ± 0.3 standard units from a known standard **Multiparameter Datalogger** After two point calibration: ±0.05 std units from both calibration standards Post Deployment : ±0.3 std. units from both calibration standards		Initial Calibration Values Post Deployment Checks Comparison to Handheld Meters
Specific Conductance	Appendix A-1; A-3, A-5, A-7, A-11	**Field Replicate** RPD ≤ 10% or ABS ≤ 25 µS/cm			Measurement replicates
			Handheld Meter ± 20% of calibration standard **Multiparameter Datalogger** After one point calibration ± 20% of calibration standard and ± 20% of another standard in the range of expected field values		± 20% of calibration standard ± 10 uS/cm Blank (air)
Turbidity	Appendix A-1	**Field Replicate** ABS ≤1.0 NTU			Measurement replicates
			± 0.25 NTU of calibration standard after calibration ± 0.25 NTU from a blank with value of 0.0 NTU		± 0.25 NTU of calibration standard ± 0.25 NTU Blank (Distilled Water)

Analytical Parameter	Analytical Method/ SOP Reference	Precision[a]	Accuracy[a]	Sensitivity[a]	QC Sample and/or Activity Used to Assess Measurement Performance
Water Temperature	Appendix A-1; A-3, A-5, A-7, A-9, A-11	**Field Replicate** RPD ≤ 10% or ABS ≤ 0.5°C	**Multiparameter Datalogger** ± 0.5 °C. from handheld meter		Measurement replicates
			Annual Pre-Season Check ± 0.2 °C. from laboratory thermometer in water bath. If greater than ± 0.2 °C. from laboratory thermometer in water bath a correction may be applied to final data		Laboratory thermometer comparison
Water Depth (Top Setting Rod)	Appendix A-10	RPD ≤ 20%			Measurement replicates
Water Depth (Datalogger)	Appendix A-3, A-5, A-7		Verification with a fixed method such as a top setting rod or stream level gage.		
Velocity	Appendix A-10	RPD ≤ 20%			Measurement replicates
			± 0.05 ft/s in still bucket If >± 0.05 reset zero		
PARAMETERS ANALYZED IN LABORATORY					
E. coli *Enterococcus*	Appendix B-14; B15	**Field Replicate** If >100 cts/100ml RPD ≤ 20% If ≤ 100 cts/100ml RPD ≤ 100%			Measurement replicates
					Lab duplicates
			≤10 counts/100 mL		Laboratory Blanks
Chlorophyll *a*	Appendix B-17	**Field Replicate** RPD ≤ 20% or ABS < ½ mean of all river Chlor *a* data in EMD			Field replicates
		ABS ≤ 3 mg/L			Laboratory duplicates

Analytical Parameter	Analytical Method/ SOP Reference	Precision[a]	Accuracy[a]	Sensitivity[a]	QC Sample and/or Activity Used to Assess Measurement Performance
Chloride (Cl) **NH PHL Laboratory**	Appendix B-5	RPD ≤ 20% or ABS < ½ mean of all river Cl data in EMD			Field replicates
		RPD ±7%			Laboratory duplicates
			$r^2 \geq 0.995$		Initial calibration
			85-115%		ICV
			85-115%		LFM recovery
				0.47 mg/L	Annual calculation of MDL
				< ½ PQL	Annual calculation of MDL
Chloride (Cl) **JCLC Limnology Lab**	Appendix B-20	RPD ≤ 20% or ABS[b] < ½ mean of all river DOP data in EMD			Field Duplicate
				< MDL	Instrument Blank
		RPD < 10%			Lab Duplicate
				< MDL	Reagent Blank
				0.23 mg/L	Annual MDL Calculation
			Cal curve R^2 >/= 0.995 RDL 3+/- 20% 100 and High 200 Stds +/-10%		Initial Calibration
			120 +/- 10%		Independent Calibration Verification
			100 +/- 10%		Continuing Calibration Verification
Total Phosphorus	Appendix B-4	If >0.015 mg/L RPD ≤ 20% If ≤ 0.015 mg/L RPD ≤ 50%			Field replicates
		RPD ±10%			Laboratory duplicates
			$r^2 \geq 0.995$		Initial calibration
			85-115%		ICV[c]
			85-115%		LFM recovery
				0.001 mg/L	Annual calculation of MDL
				< ½ PQL	Annual calculation of MDL

Analytical Parameter	Analytical Method/ SOP Reference	Precision[a]	Accuracy[a]	Sensitivity[a]	QC Sample and/or Activity Used to Assess Measurement Performance
Dissolved Ortho Phosphorus	Appendix B-3	RPD ≤ 20% or ABS[b] < ½ mean of all river DOP data in EMD			Field replicates
		RPD ±6%			Lab duplicates
			$r^2 \geq 0.995$		Initial calibration
			0.009-0.012 mg/L		ICV[a]
			0.043-0.058 mg/L		LFM recovery
				0.001 mg/L	Annual calculation of MDL
				< ½ PQL	Annual calculation of MDL
Nitrate +Nitrite (NO_3+NO_2)	Appendix B-5	RPD ≤ 20% or ABS < ½ mean of all river NO_3+NO_2 data in EMD			Field replicates
		RPD ≤ 9%			Laboratory duplicates
			$r^2 \geq 0.995$		Initial calibration
			85-115%		ICV
			85-115%		LFM recovery
				0.003 mg/L	Annual calculation of MDL
				< ½ PQL	Annual calculation of MDL
Total Kjeldahl Nitrogen (TKN)	Appendix B-7	RPD ≤ 20% or ABS < ½ mean of all river TKN data in EMD			Field replicates
		RPD ≤ 10%			Laboratory duplicates
			$r^2 \geq 0.995$		Initial calibration
			90-110%		ICV
			90-110%		LFM recovery
				0.058 mg/L	Annual calculation of MDL
				< ½ PQL	Annual calculation of MDL
Ammonia (NH_3)	Appendix B-8	RPD ≤ 20% or ABS < ½ mean of all river NH_3 data in EMD			Field replicates

Analytical Parameter	Analytical Method/ SOP Reference	Precision[a]	Accuracy[a]	Sensitivity[a]	QC Sample and/or Activity Used to Assess Measurement Performance
Ammonia (NH_3) (Cont,)		RPD ≤ 20%			Laboratory duplicates
			$r^2 \geq 0.995$		Initial calibration
			90-110%		ICV
			90-110%		LFM recovery
				0.078 mg/L	Annual calculation of MDL
				< ½ PQL	Annual calculation of MDL
Biological Oxygen Demand – 5 Day (BOD_5)	Appendix B-9	RPD ≤ 20% or ABS < ½ mean of all river BOD_5 data in EMD			Field replicates
		RPD ≤ 12%			Laboratory duplicates
			slope=0.90-1.15		Initial calibration
			88-122%		ICV
			86-128%		LFM recovery
Alkalinity	Appendix B-11	RPD ≤ 20% or ABS < ½ mean of all river Alk data in EMD			Field replicates
		RPD ≤ 6%			Laboratory duplicates
			$r^2 \geq 0.995$		Initial calibration
			91-107% (45-54 mg/L)		ICV
				0.57 mg/L	Annual calculation of MDL
				<1/4 PQL	Annual calculation of MDL
Total Solids	Appendix B-12	RPD ≤ 20% or ABS < ½ mean of all river TS data in EMD			Field replicates
		RPD ≤ 60%			Laboratory duplicates
			78-116%		ICV
Total Suspended Solids	Appendix B-13	RPD ≤ 20% or ABS < ½ mean of all river TSS data in EMD			Field replicates
		RPD ≤ 60%			Laboratory duplicates

Analytical Parameter	Analytical Method/ SOP Reference	Precision[a]	Accuracy[a]	Sensitivity[a]	QC Sample and/or Activity Used to Assess Measurement Performance
			76-114%		ICV
Total Organic Carbon (TOC)	Appendix B-2	RPD ≤ 20% or ABS[b] < ½ mean of all river TOC data in EMD			Field replicates
		RPD < 30%			Lab duplicates
			$r^2 \geq 0.995$		Initial calibration
			80-120%		ICV[a]
			80-120%		LFM recovery
				0.103 mg/L	Annual calculation of MDL
				< ½ PQL	Annual calculation of MDL
Sulfate (SO_4)	Appendix B-6	RPD ≤ 20% or ABS < ½ mean of all river SO_4 data in EMD			Field replicates
		RPD < 20%			Lab duplicates
			$r^2 \geq 0.995$		Initial calibration
			85-115%		ICV
			85-115%		LFM recovery
				0.016 mg/L	Annual calculation of MDL
				< ½ PQL	Annual calculation of MDL
Calcium (Ca)	Appendix B-10	RPD ≤ 20% or ABS < ½ mean of all river Ca data in EMD			Field replicates
		RPD < 5%			Lab duplicates
			$r^2 \geq 0.995$		Initial calibration
			85-115%		ICV
			85-115%		LFM recovery
				0.033 mg/L	Annual calculation of MDL
				< ½ PQL	Annual calculation of MDL
Magnesium (Mg)	Appendix B-10	RPD ≤ 20% or ABS < ½ mean of all river Mg			Field replicates

Analytical Parameter	Analytical Method/ SOP Reference	Precision[a]	Accuracy[a]	Sensitivity[a]	QC Sample and/or Activity Used to Assess Measurement Performance
		data in EMD			
		RPD < 4%			Lab duplicates
			$r^2 \geq 0.995$		Initial calibration
			85-115%		ICV
			85-115%		LFM recovery
				0.007 mg/L	Annual calculation of MDL
				< ½ PQL	Annual calculation of MDL
Potassium (K)	Appendix B-10	RPD ≤ 20% or ABS < ½ mean of all river K data in EMD			Field replicates
		RPD < 2%			Lab duplicates
			$r^2 \geq 0.995$		Initial calibration
			85-115%		ICV
			85-115%		LFM recovery
				0.012 mg/L	Annual calculation of MDL
				< ½ PQL	Annual calculation of MDL
Sodium (Na)	Appendix B-10	RPD ≤ 20% or ABS < ½ mean of all river Na data in EMD			Field replicates
		RPD < 3%			Lab duplicates
			$r^2 \geq 0.995$		Initial calibration
			85-115%		ICV
			85-115%		LFM recovery
				0.03 mg/L	Annual calculation of MDL
				< ½ PQL	Annual calculation of MDL
Hardness	Appendix B-10	RPD ≤ 20% or ABS < ½ mean of all river Hard data in EMD			Field replicates
		RPD ≤ 5%			Laboratory duplicates
			$r^2 \geq 0.995$		Initial calibration

Analytical Parameter	Analytical Method/ SOP Reference	Precision[a]	Accuracy[a]	Sensitivity[a]	QC Sample and/or Activity Used to Assess Measurement Performance
			85-115%		ICV
			85-115%		LFM recovery
				0.075 mg/L	Annual calculation of MDL
				< ½ PQL	Annual calculation of MDL
Aluminum (Al)	Appendix B-10	RPD ≤ 20% or ABS < ½ mean of all river Al data in EMD			Field replicates
		RPD ≤ 5%			Laboratory duplicates
			$r^2 \geq 0.995$		Initial calibration
			85-115%		ICV
			85-115%		LFM recovery
				0.006 mg/L	Annual calculation of MDL
				< ½ PQL	Annual calculation of MDL
Copper (Cu)	Appendix B-10, B-16	RPD ≤ 20% or ABS < ½ mean of all river Cu data in EMD			Field replicates
		RPD ≤ 5.2%			Laboratory duplicates
			$r^2 \geq 0.995$		Initial calibration
			85-115%		ICV
			85-115%		LFM recovery
				0.001 mg/L	Annual calculation of MDL
				< ½ PQL	Annual calculation of MDL
Lead (Pb)	Appendix B-10; B-16	RPD ≤ 20% or ABS < ½ mean of all river Pb data in EMD			Field replicates
		RPD ≤ 6.7%			Laboratory duplicates
			$r^2 \geq 0.995$		Initial calibration
			85-115%		ICV
			85-115%		LFM recovery
				0.001 mg/L	Annual calculation of MDL

Analytical Parameter	Analytical Method/ SOP Reference	Precision[a]	Accuracy[a]	Sensitivity[a]	QC Sample and/or Activity Used to Assess Measurement Performance
				< ½ PQL	Annual calculation of MDL
Zinc (Zn)	Appendix B-10	RPD ≤ 20% or ABS < ½ mean of all river Zn data in EMD			Field replicates
		5%RPD			Laboratory duplicates
			$r^2 \geq 0.995$		Initial calibration
			85-115%		ICV
			85-115%		LFM recovery
				0.001 mg/L	Annual calculation of MDL
				< ½ PQL	Annual calculation of MDL

[a]Measurement performance criterion determined through previous experience and statistical analysis of available data in NHDES Environmental Monitoring Database
[b]ABS = Absolute difference
[c]ICV = Initial calibration verification

A7.2 Accuracy

Accuracy is quantified for field and laboratory activities, including, but not limited to, comparison with known standards, initial calibration verifications, and laboratory fortified matrices (Table 4). Complete definitions of accuracy for laboratory activities are provided in the SOPs for individual parameters (Appendix B).

A7.3 Representativeness

VRAP aims to identify and/or confirm the occurrence of impaired or potentially impaired waterways in the state of New Hampshire. Many water quality parameters are spatially and temporally dynamic, and typically experience near-limiting ambient conditions (*e.g.*, low stream flow, warm water temperature) during the summer. For example, dissolved oxygen concentrations are typically lowest during the early morning hours in response to photosynthetic/respiration cycles and chloride levels tend to be highest during low-flow summer periods and during snowmelt events. Spatial dynamics relate to many attributes, including land use, geology, and the river channel.

A7.4 Comparability

VRAP employs field and laboratory instrumentation and methodology consistent among sampling locations. Although field measurements are made at each station on different days throughout the summer, temporally dependent measurements are made during the same time of day to the extent possible (*i.e*. VRAP participants are encouraged to measure dissolved oxygen between 6 A.M. and 10 A.M. when levels are generally the lowest in the diurnal cycle.) In addition, water samples are collected and transported to the NH DHHS Public Health Lab, JCLC, or other approved laboratory during similar times of day. This is consistent with procedures used during previous monitoring activities.

A7.5 Sensitivity

The VRAP program is a data collection mechanism used to determine whether rivers and streams meet state surface water quality standards. With the exception of copper and lead, the field and laboratory instrumentation used in the VRAP have quantitation limits below the water quality standards for each parameter and results can be used to determine whether a waterbody meets the surface water quality standards or if it is considered impaired or potentially impaired in accordance the most recent version of the NHDES Consolidated Assessment and Listing Methodology (CALM). Since the laboratory quantification limits for copper and lead are higher than the water quality standard, only results above the water quality standard are used to make assessment decisions and in such a case would be considered impaired. In accordance with the CALM, copper or lead results below the water quality standard are considered insufficient information for making assessment decisions. Specific detection limits are provided in Table 5, below.

A7.6 Quantitation Limits

All laboratory analyzed water quality parameters evaluated through VRAP have specific quantitation limits, which are shown in Table 5. The laboratory quantitation limits are subject to annual changes, based on changes in instrumentation technology and operating procedures.

A7.7 Completeness

Data collected by VRAP is voluntary and thus any amount of data collected is usable for making assessments. However, the goal is to collect at least 75% of the data scheduled by individual VRAP group's SAPs each year.

Table 5. Surface Water Target Analytes and Reference Limits

Analyte	Analytical method (See Appendix B for SOPs)	Method Detection Limits (MDL)	Reporting Detection Limits (RDL)
Laboratory Analysis			
Total Organic Carbon (TOC)	EPA 415.3	0.324 mg/L	0.5 mg/L
Dissolved Ortho Phosphorus (DOP)	NHDES 10.19a; Lachat QuikChem Method 10-115-01-1-B	0.001 mg/L	0.01 mg/L
Total Phosphorus (TP)	Lachat 10-115-01-1-F	0.001 mg/L	0.005 mg/L
Nitrate/Nitrite (NO_3+NO_2)	Lachat 10-107-04-1-C	0.011 mg/L	0.05 mg/L
Chloride (Cl) **NH PHL Laboratory**	NHDES 10.04f; Lachat Quik Chem Method 10-511-00-1-A	0.472 mg/L	3.0 mg/L
Chloride (Cl) **JCLC Laboratory**	Standard Method D512C	Not Calculated	3.0 mg/L
Sulfate (SO_4)	NHDES 10.04f; Lachat Quik Chem Method 10-511-00-1-A	0.06 mg/L	1.0 mg/L
Total Kjeldahl Nitrogen (TKN)	EPA-600/4-79-020, Method 351.2; Lachat Method #10-107-06-2-E	0.038 mg/L	0.25 mg/L
Ammonia (NH_3)	Standard Method 4500-NH3-B (APHA, 1995); 1. Lachat Method #10-107-06-1-A	0.078 mg/L	0.25 mg/L
Biological Oxygen Demand (BOD_5)	EPA 600/4-79-020, Method 360.1; Standard Method 5210 B (APHA, 1995)	None	2.0 mg/L
Hardness	EPA 200.7	1 mg/L	3 mg/L
Alkalinity	EPA 600/4-79-020, Method 310.1; Standard Method 2320 B (APHA, 1995)	0.45 mg/L	1.0 mg/L
Total Solids (TS)	EPA 600/4-79-020, Method 160.3; Standard Method 2540 B (APHA, 1995)	8.3	20 mg/L
Total Suspended Solids (TSS)	EPA 600/4-79-020, Method 160.2; Standard Method 2540 D (APHA, 1995)	2.8	10 mg/L

Analyte	Analytical method (See Appendix B for SOPs)	Method Detection Limits (MDL)	Reporting Detection Limits (RDL)
E. coli	Membrane Filter Procedure, EPA 600/4-85/076; EPA Method 1603	0+ cts/100 mL (depends on dilution and sample volume)	0+ cts/100 mL (depends on dilution and sample volume)
Aluminum (Al)	EPA 200.7	0.006 mg/L	0.015 mg/L
Calcium (Ca)	EPA 200.7	0.033 mg/L	1.0 mg/L
Copper (Cu)	EPA 200.8	0.0001 mg/L	0.002 mg/L
Lead (Pb)	EPA 200.8	0.0001 mg/L	0.001 mg/L
Magnesium (Mg)	EPA 200.7	0.07 mg/L	0.1 mg/L
Potassium (K)	EPA 200.7	0.012 mg/L	0.25 mg/L
Sodium (Na)	EPA 200.7	0.03 mg/L	1.0 mg/L
Zinc (Zn)	EPA 2008	0.0001 mg/L	0.01 ug/L
Chlorophyll *a*	Standard Methods (1998) Method 10200H	0.2 mg/L	0.2 mg/L

A8 Special Training/Certification

A8.1 Personnel Responsibilities and Qualifications

Table 6 details personnel responsibilities and qualifications.

Table 6. Personnel Responsibilities and Qualifications

Name	Organization	Responsibilities	Education and Experience
Gregg Comstock	NHDES Watershed Bureau	Water Quality Planning Section Supervisor	Refer to Appendix C-1*
Ted Walsh	NHDES Watershed Bureau	VRAP Program Manager	Refer to Appendix C-1*
Amanda Bridge	NHDES Watershed Bureau	VRAP Program Coordinator	Refer to Appendix C-1*
Margaret Foss	NHDES Watershed Bureau	VRAP QA/QC Officer	Refer to Appendix C-1*
Melanie Cofrin	NHDES Watershed Management Bureau	Database Management	Refer to Appendix C-1*
Vincent Perelli	NHDES Commissioner's Office	NHDES QA Manager / QAPP Reviewer	Refer to Appendix C-1*
Rachel Rainey	NH DHHS Public Health Laboratory	Sample analysis and lab QA	Refer to Appendix C-1*

Scott Ashley	NHDES Biology Section	QA/QC and Database Coordinator JCLC Laboratory	Refer to Appendix C-1*

* NHDES Supplemental Job Descriptions (SJDs) submitted in lieu of resumes.

Any special training requirements or certifications for the above listed parties are detailed in the NHDES SJD or the resume for each person, which are included in Appendix C-1. Table 7 summarizes the intern training requirements and certification, and Table 8 summarizes volunteer training requirements and certification. VRAP encourages all participants to attend and annual training session. However, new volunteers are often recruited after the train sessions have concluded and some participants are unable to attend due to time constraints. Those VRAP group coordinators that have sufficient experience to train their own volunteers can do so but will notify the Program Manager of those volunteers whom they have trained.

Table 7. Special Training Requirements for VRAP Intern

Project Function	Description of Training	Training Provided by	Training Provided to	Location of Training Records
Water Sample Collection	Handheld instrument, datalogger, and laboratory sample and data collection procedures, provided in the field	NHDES VRAP Program Manager/Coordinator	NHDES VRAP Intern and other WQPS interns that may be required to assist with VRAP	NHDES
Water Sample Analysis	Analysis of water samples in the laboratory	NHDES VRAP Program Manager/Coordinator	NHDES VRAP Intern and other WQPS interns that may be required to assist with VRAP	NHDES
Data Management	Logging in samples into Limnology Center database	NHDES Biology section QA/QC Coordinator, & Database Manager	NHDES VRAP Intern and other WQPS interns that may be required to assist with VRAP	NHDES
Data Management	Entering sample results into Environmental Monitoring Database	NH NHDES Environmental Database	NHDES VRAP Intern and other WQPS interns that may be required to assist with VRAP	NHDES
Data Analysis	Analyzing and interpreting data and compiling annual VRAP reports	NHDES VRAP Program Manager/Coordinator	NHDES VRAP Intern	NHDES

Table 8. Special Training Requirements for Volunteer Monitors

Project Function	Description of Training	Training Provided by	Training Provided to	Location of Training Records
Water Sampling	Water sample collection procedures (VRAP annual training sessions)	Program Manager and/or Program Coordinator and trained WQPS staff	Volunteer Monitors	NHDES Refer to Appendix C-3 for sample schedule for annual VRAP trainings. Refer to Appendix C-4 for the VRAP Training Sign-in sheets and C-5 for Training Agenda
Water Sampling	Water sample collection procedures in the field during an annual field audit for VRAP groups	VRAP staff	Volunteer Monitors	NHDES WQPS Office Refer to Appendix C-6 for the VRAP Self-Assessment Form
Water Sampling	When samples are dropped off at the laboratory by volunteers the chain of custody form is used to determine if any corrective actions are needed in sample documentation.	Laboratory Managers and Interns VRAP staff	Volunteer Monitors	NH DHHS Public Health Laboratory NHDES JCLC Wastewater Treatment Facilities Accredited Laboratories Refer to Appendix B-1 for the VRAP Chain of Custody Form.

A9 Documents and Records

A9.1 Communication Pathways

The Program Manager and Program Coordinator are the primary contacts for all staff involved with VRAP. Dialogue exists between VRAP staff and other WMB staff regarding the ongoing development of the VRAP program and implementation of the annual sampling and analysis plans. The Program Manager provides overall program and work plan direction to the Program Coordinator and VRAP intern. The Program Coordinator is the primary contact for day-to-day communication with volunteers regarding equipment and supply needs, trainings, field audits and general technical assistance. The Program Manager is also available as a contact for the volunteers but is more focused on program development, supplemental monitoring, 305(b)/303(d) reporting, complaints, and potential enforcement actions. The Program Manager provides direction to the VRAP Coordinator and VRAP intern throughout the data collection period and is notified of any problems associated with data collection, QA/QC procedures, or sample analysis. The Program Coordinator directs the VRAP volunteers throughout the data collection period. The VRAP intern and volunteers inform the Program Manager and Program Coordinator of any problems associated with data collection or logistics. The Program Manager and Program Coordinator

delegate corrective actions to the VRAP interns and volunteers as necessary and consult the Laboratory QA Manager and WQPS Supervisor as necessary. VRAP staff conducts a quality assurance evaluation of all VRAP data (i.e. field measurements and laboratory analyses) after the conclusion of the data collection period and notify WQPS staff and the Environmental Monitoring Database Manager of the availability of final VRAP data. The Program Manager will report to the NHDES Quality Assurance Manager and EPA annually regarding the status of the QAPP and document any modifications that may have been made. The Program Coordinator will report to the volunteers in written report format the results of annual monitoring efforts and the annual QA audit of the program. The results of annual VRAP sampling are made available to the Water Quality Assessment Program Manager via the Environmental Monitoring Database for 305(b)/303(d) reporting.

A9.2 Modifications to Approved QAPP

The Program Manager will be responsible for maintaining the approved QAPP and for distributing the latest version of the plan to all parties on the distribution list (Table 1). A copy of the approved plan will be on file at the NHDES Water Quality Planning Section office in Concord.

Modification and/or addendums to this VRAP QAPP will be documented and reported to EPA New England according to the following procedures:

A9.2.1 Sampling and Analysis Plans

If the annual sampling and analysis plan of a given VRAP group will deviate from the procedures and methods described in the VRAP QAPP, it will be documented in the sampling and analysis plans prepared by the VRAP group and VRAP staff prior to field work. A copy of the approved plan will be retained in the VRAP files and will be made available to the NHDES Quality Assurance Manager and EPA upon request.

A9.2.2 Sample Collection Procedures

Each year, the Program Manager and Program Coordinator review the VRAP Field Operations Manual and all standard operating procedures (SOPs) for sample collection and processing throughout the monitoring period to identify existing deficiencies and the potential for additional deficiencies or potential increased efficiency. The Field Manual and SOPs are revised following the completion of the primary monitoring period (April - October).

Any substantive revisions to the SOPs (*e.g.*, deletions of previously approved section) are reviewed by WQPS staff and then approved by the WQPS Supervisor. VRAP groups are notified of the availability of the revised SOPs immediately upon final approval. All outdated SOPs are retained electronically on the NHDES computer network. Any subsequent modifications are documented by the Program Manager in annual quality assurance program self-audits, which are required under the NHDES Quality Management Plan (QMP). The revised SOP and self-audits are available to EPA New England upon request by EPA New England.

A9.2.3 Sample Analysis Procedures

Each year the Program Manager and Program Coordinator reviews the field analytical SOPs and consults the Laboratory QA Manager to discuss the need for modifications to the laboratory analytical SOPs. VRAP staff revise the field analytical SOPs as described in A9.2.2, above. The Program Manager receives copies of any new or revised VRAP-specific laboratory analytical SOPs from the Laboratory QA Manager. Any subsequent modifications are documented by VRAP staff in annual quality assurance

program self-audits, which are required under the NHDES Quality Management Plan (QMP). The SOPs, SAPs, and self-audits are available to EPA New England upon request by EPA New England.

A9.2.4 Data Assessment and Reporting

Each year, prior to the commencement of water quality monitoring, the Program Manager consults the Laboratory QA Manager and the WQPS Supervisor, as necessary, to discuss the need for modifications to the data assessment and reporting procedures. Any subsequent modifications are documented by the Program Manager in annual quality assurance program self-audits, which are required under the NHDES Quality Management Plan (QMP). The self-audits are available to EPA New England upon request by EPA New England.

A9.3 Project Documentation and Records

Table 9 discusses the documentation and records that will be generated through VRAP.

Table 9. Project Documentation and Records Table

Laboratory and Field Sampling SOP Training Records	Sample Collection Records	Field Analysis Records	Fixed Laboratory Records	Project Data Assessment Records
VRAP Annual Training Workshop Attendance List	Field Data Sheets (Refer to Appendix A-2)	Raw field data	Bench book records	Annual VRAP QA/QC Report
VRAP Field Self Audits Reporting Forms (Appendix C-6)	VRAP Laboratory Form (Refer to Appendix B-1)	Datalogger Field Data	Computer databases	
NHDES VRAP Intern Field Sampling Procedures Training Assessment Form (Refer to Appendix A-1)	Datalogger Calibration and Deployment Datasheets (A-4, A-6, A-8)		Billing receipts for sample analysis	

A9.4 Field Analysis Data Deliverables

Field analytical data represent definitive data for VRAP. Field measurements (*e.g.*, pH, water temperature, etc.) are made concurrent with sample collection for laboratory analysis. Similarly, the sampling stations are characterized at the time of sampling relative to general in-channel, riparian, and upland attributes. Field measurement data and sampling station attribute information are recorded on field data sheets. An annual VRAP folder for each VRAP group contains all field data sheets, laboratory reports, field audits, and other pertinent information for each calendar year. These records are indefinitely retained in the Water Quality Planning Section office.

A9.5 Fixed Laboratory Data Deliverables

Data analyzed in the NH DHHS Public Health Laboratory are electronically entered into the Environmental Monitoring Database upon completion of the analyses. Laboratory login sheets and custody sheets are retained at NHDES.

Data from parameters analyzed in the NHDES JCLC are entered immediately upon analysis into meter-respective bench books. These data are then entered weekly into the sample login system and cross-referenced with bench book data upon printout.

A9.6 Data Reporting Formats

VRAP participants are instructed to record all field data and information in ink on the field data sheets. VRAP participants are also instructed to correct any recording errors by striking the error and recording the new data next to or above the erroneous record. The data being collected in the field are collected following the procedures outlined in NHDES's Quality Management Plan guidance as outlined in Section A8. Field data sheets shown in Appendix A-2 will be used by volunteers to record field data. Field datasheet show in Appendix A-4, A-6, and A-8 will be used by VRAP staff to record datalogger calibration data.

Field measurement data are entered manually into the NHDES Environmental Monitoring Database, whereas laboratory analytical results are entered into the LIMS database or Limnology Center database. All laboratory data are automatically uploaded to the EMD. The Program Manager receives verification from a data analyst regarding the success or failure of the automatic upload to the EMD.

A9.6.1 Annual VRAP Water Quality Reports

Each year VRAP staff prepare and distribute a water quality report for each VRAP group that is based solely on the water quality data collected by that group during a specific year. The reports summarize and interpret the data, particularly as they relate to New Hampshire's surface water quality standards, provides recommendations for future sampling efforts, and serves as a teaching tool and guidance document for future monitoring activities by the individual volunteer groups. Each annual report includes the following:

- **Volunteer River Assessment Program Overview**

  This section includes a description of the history of VRAP, the technical support, training and guidance provided by NHDES, and how data is transmitted to the volunteers and used in surface water quality assessments.

- **Monitoring Program Description**

  This section provides a description of the volunteer group's monitoring program including monitoring objectives as well as a table and map showing sample station locations.

- **Results and Recommendations**

  Water quality data collected during the year are summarized on a parameter-by-parameter basis using: (1) a data summary table, which includes the number of samples collected, data ranges, the number of samples meeting New Hampshire water quality standards, and the number of samples adequate for water quality assessments at each station; (2) a discussion of the data; (3) a river graph showing the range of measured values at each station; and (4) a list of applicable recommendations. Where applicable, the river graph also shows New Hampshire surface water quality standards or levels of concern for comparison purposes.

- **Appendix A – Water Quality Data**

  This appendix includes a spreadsheet detailing the data results and additional information such as data results which do not meet New Hampshire surface water quality standards, and data that are unusable for assessment purposes due to quality control requirements.

- **Appendix B – Interpreting VRAP Water Quality Parameters**

This appendix provides a brief description of water quality parameters typically sampled by VRAP volunteers and their importance, as well as applicable state water quality criteria or levels of concern.

- **Appendix C – VRAP Field Audit**

  This appendix provides and overview of the VRAP field audit process with respect of programmatic QA/QC guidelines

- **Additional Appendices Vary from Year to Year**

A9.7 Annual Program Self-Audit (QA/QC Report)

The Annual VRAP QA/QC Report will document the number of waterbodies sampled and the number of sample results generated by VRAP each season. The QA/QC report will provide documentation on how the program met or did not meet QA/QC goals. In addition, the report will discuss problems that were encountered during the sampling season and will provide solutions to these problems that will be implemented during the next sampling season. Per the NHDES Quality Management Plan, Section 9, this report will be provided to the NHDES QA Manager. The NHDES QA Manager will compile all of the Annual QA reports for each program at NHDES and will report to the senior leaders at NHDES and EPA.

B. DATA GENERATION AND ACQUISITION ELEMENTS

B1 Sampling Process Design

VRAP supports diverse water quality monitoring programs to satisfy the needs of individual volunteer groups. Since water quality monitoring under VRAP is completely voluntary, a concrete sampling design need not be established. In lieu of this, each VRAP group is required to submit an annual Sampling and Analysis Plan (SAP) (Appendix C-7). The monitoring programs often have spatial and temporal limitations, which are not considered prohibitive for volunteer monitoring. For example, in many cases, volunteer groups are concerned about the impacts of land and water management practices. Therefore, the groups choose to establish sampling stations relative to a particular area of concern (*e.g.*, landfill, wastewater treatment facility). In other cases, volunteer groups prefer to examine the background or general conditions of local rivers and streams. The temporal limitations are a result of volunteer and equipment availability. In many cases, volunteer groups are available to sample every other week throughout the summer months. In other cases, volunteers are available to sample monthly throughout the year. VRAP encourages volunteers to sample a minimum of once a month during the summer.

SAPs are developed by the individual volunteer groups, and may differ from year to year depending on the concerns/needs of the volunteers. The rationale for sampling, and specific sampling information (*e.g.*, analytes, number of samples, etc.) are documented in annual SAPs developed by the individual volunteer groups and VRAP staff. The SAPs are retained at NHDES.

NHDES uses the Consolidated Assessment and Listing Methodology (CALM) to facilitate the development of 303(d) lists and 305(b) reports for the State of New Hampshire. These documents are supported by data collected under VRAP. Thus, if requested by individual volunteer groups, NHDES provides sampling design guidance relative to statewide surface water quality assessments and evaluates water quality according to established narrative and numeric surface water quality standards.

Table 10 is an example of the types of activities conducted by VRAP during any given year, but additional parameters may be added if a specific monitoring need is identified. This table is updated in annual VRAP SAPs provided by the individual VRAP groups.

Table 10. Surface Water Field Sample Summary

Analyte (Variable year to year, including, but not limited to)	Sample Type	Number of sampling stations	Sampling Frequency	Number of field replicates	Total Number of samples to lab
· Alkalinity · Aluminum (Al) · Ammonia (NH3) · Biological Oxygen Demand (BOD5) · Calcium (Ca) · Chloride (Cl) · Chlorophyll a · Copper (Cu) · Discharge · Dissolved Orthophosphorus (DOP) · Dissolved Oxygen · E.coli/Enterococcus · Hardness · Lead (Pb) · Magnesium (Mg) · Nitrate+Nitrite (NO3+NO2) · pH · Potassium (K) · Sodium (Na) · Specific Conductance · Sulfate (SO4) · Total Kjeldahl Nitrogen (TKN) · Total Organic Carbon (TOC) · Total Phosphorus (TP) · Total Solids · Total Suspended Solids · Turbidity · Velocity · Water Temperature · Zinc (Zn)	Surface Grab	Variable year to year; typical range: 5-25	Variable year to year; typically a minimum of monthly from May through October	Variable, based on sampling frequency	Variable, based on sampling frequency
• Dissolved oxygen • pH • Specific conductance • Turbidity • Water Level • Water Temperature	In-situ measurement (continuous)	Variable year to year	Variable year to year; typically every 15 mins. for a minimum 5 day deployment	none	none

B2 Sampling Collection Procedures

B2.1 Instantaneous Sampling Procedures

VRAP uses a routine, standardized approach to collecting water quality data. This approach increases consistency among samplers, facilitates the collection of accurate and precise data, increases the representativeness of samples, and augments data comparability. All sampling activities, including field measurements and water sample collection, are typically conducted between 6:00 a.m. and 4:00 p.m on any given day of the week. Sample collection procures are provided to VRAP groups and all volunteers in the form of the annually updated "VRAP Water Quality Monitoring Field Sampling Protocols for Volunteer Monitors" (Appendix A-1).

Samples for laboratory analyses are collected using various methods based on the access to the river or stream. In many cases, samples are collected using a bucket (two-gallon, five-gallon, etc.) suspended from road crossings (bridges) and sampled from the upstream side of the middle of the bridge/river to obtain the most representative sample. For sample collection, the bucket is filled with as much water as possible to ensure sufficient volume for all water sample bottles and field measurements. However, should the water sample in the bucket be significantly agitated (*i.e.*, observed bubbles and splashing), the sample is discarded and a subsequent sample is collected. This is considered a surface grab sample since the bucket sampling technique collects water from the top one foot of the water column. In some cases volunteers will collect samples directly from the waterbodies by dipping the bottle or bucket mid-channel. This is only encouraged in smaller streams where wading can be done safely. The VRAP field protocols in Appendix A-1 provide SOP's for collecting samples both in-stream and via a bucket. Any change to the sampling methods will be documented on the field data sheets and subsequently examined by VRAP staff to determine the validity of the data.

Samples for laboratory analysis are immediately transferred from the bucket to individual water sample bottles, appropriately preserved, and stored on ice from the time of collection until the time they are relinquished to the laboratory (Table 12). Samples for laboratory analysis collected directly from the stream are also immediately stored on ice. Sample collection, preservation, and storage procedures are followed according to the SOP in Appendix B-1 and Appendix B-18.

Similar to the collection of samples for laboratory analysis, field measurements are made using various methods, based on the access to the river or stream. (See Appendix A-1 for the sample collection SOP.) Field measurements include water temperature, dissolved oxygen, pH, specific conductance, velocity, water level, and discharge. Individual field meters are used to measure field water quality parameters directly from the bucket or in-stream. It is important to note that if a bucket is used, samples for laboratory analysis are poured off the bucket prior to any field meters being immersed in the bucket. Individual meters are calibrated and used to record measurements according the SOP's referenced in Table 11 and per instructions from the manufacturer of the instrument. Sampling, washing, cleaning, and decontamination procedures are followed according to the SOP in Appendix A-1 (Table 12). Any comments relevant to the sampling event (e.g., sampling and/or instrumentation problems) are documented on field data sheets prior to traveling to the next sampling station. This procedure is repeated at all scheduled sampling stations for a particular day. All water samples are transported to the laboratory after the final station has been sampled. This is completed on the same day as collection for *E.coli* samples and varies for other parameters based on the holding times for each laboratory parameter (Table 11).

Table 11. Sample requirements

Analytical parameter	Collection method	SOP's (Appendix)	Sample volume	Container size and type	Preservation requirements	Max. holding time (preparation and analysis)
Laboratory Parameters (collected in the field, preserved, analyzed in the laboratory)						
Total Organic Carbon (TOC)	Surface Grab	B-2	40 mL	2 x 40 mL amber	2 drops of conc. H_3PO_4 to pH<2 chilled to 4°C	28 days
Dissolved Ortho Phosphorus (DOP)	Surface Grab	B-3	50 mL	60 mL polyethylene or glass	Filtered through 0.45µm; freeze within 48 hours	48 hours (unfrozen chilled to 4°C); 6 months (frozen)
Total Phosphorus (TP)	Surface Grab	B-4, B-21	50 mL	250 mL brown polyethylene	H_2SO_4 to pH<2, light protected, chilled to 4°C	28 days
Nitrate+nitrite (NO_3+NO_2)	Surface Grab	B-5	40 mL	40 mL or 250 mL white polyethylene	chilled to 4°C	48 hours
Chloride (Cl)	Surface Grab	B-5 B-20	40 mL	40 mL or 250 mL white polyethylene	chilled to 4°C	28 days
Sulfate (SO_4)	Surface Grab	B-6	40 mL	40 mL or 250 mL white polyethylene	chilled to 4°C	28 days
Total Kjeldahl Nitrogen (TKN)	Surface Grab	B-7	40 mL	250 mL light protected polyethylene	H_2SO_4 to pH<2, chilled to 4°C	28 days
Ammonia (NH_3)	Surface Grab	B-8	50 mL	250 mL light protected polyethylene	H_2SO_4 to pH<2, chilled to 4°C	28 days
Biological Oxygen Demand (BOD_5)	Surface Grab	B-9	500 mL	½ gal polyethylene	chilled to 4°C	48 hours
Hardness	Surface Grab	B-10	500 mL	500 mL LDPE or HDPE	HNO_3 to pH<2, chilled to 4°C	6 months
Alkalinity	Surface Grab	B-11	500 mL	500 mL LDPE or HDPE no head space	chilled to 4°C	14 days
Total Solids (TS)	Surface Grab	B-12	100 mL	½ gal polyethylene	chilled to 4°C	7 days
Total Suspended Solids (TSS)	Surface Grab	B-13	100 mL	½ gal polyethylene	chilled to 4°C	7 days
E. coli	Surface Grab	B-14, B-21	100 mL	250 mL sterile white polyethylene	chilled to ≤ 10°C	8 hours[a]
Aluminum (Al)	Surface Grab	B-10	500 mL	40 mL or 500 mL LDPE or HDPE	HNO_3 to pH<2, chilled to 4°C	6 months
Calcium (Ca)	Surface Grab	B-10	500 mL	500 mL LDPE or HDPE	HNO_3 to pH<2, chilled to 4°C	6 months
Copper (Cu)	Surface Grab	B-10	500 mL	500 mL LDPE or HDPE	HNO_3 to pH<2, chilled to 4°C	6 months
Lead (Pb)	Surface Grab	B-10	500 mL	500 mL LDPE or HDPE	HNO_3 to pH<2, chilled to 4°C	6 months
Magnesium (Mg)	Surface Grab	B-10	500 mL	500 mL LDPE or HDPE	HNO_3 to pH<2, chilled to 4°C	6 months
Potassium (K)	Surface Grab	B-10	500 mL	500 mL LDPE or HDPE	HNO_3 to pH<2, chilled to 4°C	6 months
Sodium (Na)	Surface Grab	B-10	500 mL	500 mL LDPE or HDPE	HNO_3 to pH<2, chilled to 4°C	6 months
Zinc (Zn)	Surface Grab	B-10	500 mL	500 mL LDPE or HDPE	HNO_3 to pH<2, chilled to 4°C	6 months
Chlorophyll *a*[b]	Surface Grab	B-17	500 mL	500 mL opaque polyethylene	Unfiltered, dark, 4°C	24 hours
					Filtered, dark – 20°C	28 days

Analytical parameter	Collection method	SOP's (Appendix)	Sample volume	Container size and type	Preservation requirements	Max. holding time (preparation and analysis)
Field Parameters (measurements/ sample collection made in the field)						
Water Temperature	*In situ* instantaneous or surface grab	A-1	NA	NA	NA	NA
Dissolved oxygen	*In situ* instantaneous or surface grab	A-1	NA	NA	NA	NA
pH	*In situ* instantaneous or surface grab	A-1	NA	NA	NA	NA
Specific Conductance	*In situ* instantaneous or surface grab	A-1	NA	NA	NA	NA
Water Level	*In situ* instantaneous	A-12	NA	NA	NA	NA
Velocity	*In situ* instantaneous	A-10	NA	NA	NA	NA
Discharge	*In situ* instantaneous	A-10	NA	NA	NA	NA
Turbidity	Surface Grab	A-1	15 mL	15 mL, clear glass	NA	NA
Water Temperature	*In situ;* programmed measurement interval	A-1, A-3, A5, A-7, A-9	NA	NA	NA	NA
Dissolved oxygen	*In situ;* programmed measurement interval	A-3, A5, A-7	NA	NA	NA	NA
pH	*In situ;* programmed measurement interval	A-3, A5, A-7	NA	NA	NA	NA
Specific Conductance	*In situ;* programmed measurement interval	A-3, A5, A-7, A-11	NA	NA	NA	NA
Turbidity	*In situ;* programmed measurement interval	A-3, A5, A-7	NA	NA	NA	NA

[a]Maximum transport time is 6 hours; must begin analysis within 2 hours after receipt at laboratory
[b]Two-step process, with filtration occurring within 24 hours and analysis within 28 days (storage in freezer before analysis)

Table 12. Project Sampling SOP Reference Table

SOP title, revision date and/or number	Reference number (Appendix)	Originating organization	Equipment used
Sampling: Volunteer River Assessment Program Standard Operating Procedures (SOP): Sampling	A-1	NHDES	Water sample bottles; plastic bucket; individual hand held field meters, cooler with ice
Preservation: State of N.H. DHHS Public Health Laboratory: Sample Preservation	B-18	NHDES	Water sample bottles
Washing: State of N.H. Environmental Services Laboratory: Washroom	B-19	NHDES	Water sample bottles
Cleaning: Volunteer River Assessment Program Standard Operating Procedures (SOP): [Sampling; Dissolved oxygen/Temperature; pH; Specific Conductance; Turbidity]	A-1, A-3, A-5, A-7, A-11	Manufacturer of handheld meters or multiprobes	Electronic meters
Decontamination: Volunteer River Assessment Program Standard Operating Procedures (SOP): [Sampling; Dissolved oxygen/Temperature; pH; Specific Conductance; Turbidity]	A-1, A-3, A-5, A-7, A-11	Manufacturer of handheld meters or multiprobes	Electronic meters

B2.2 Datalogger Deployment

Continuous measurements are collected for dissolved oxygen, pH, specific conductance, water temperature and water level using programmable, automated datalogger units, following NHDES or EPA-NE SOPs (Appendix A-3, A-5, A-7, A-9, A-11 and A-12). Deployment information is recorded on a standardized Datalogger Field Data Sheet (Appendix A-4, A-6, A-8, and A-14). The dataloggers are deployed for varying lengths of time depending on the parameters to be measured. Deployments measuring dissolved oxygen and/or pH are generally no more than two weeks in length in order to maintain the accuracy of the pre-deployment calibrations and to avoid potential drift from the calibration settings. Multiparameter datalogger deployments measuring only specific conductance and water temperature generally last no more than a six week period between QA/QC checks and if needed re-calibration. Deployment of water level dataloggers and water temperature dataloggers may be on a permanent basis for the life of the instrument.

Dataloggers are generally programmed for a measurement interval of 15 minutes or one hour in the case of long-term deployment of water temperature dataloggers. The dataloggers are secured to either the streambed or the shoreline and are secured using a variety of methods. They are situated in the stream with the sensor end facing directly into stream flow (whenever possible) at a stream depth ranging from one-three feet, depending on maximum water depth. The dataloggers are affixed to reinforced cable; the cable is padlocked to trees along the stream bank. The approximate water depth at the datalogger location and the approximate sensor depth are documented on the field data sheet at each sampling station. A spare set of supplies and equipment (*e.g.*, batteries, straps, cinder blocks, etc.) accompany field personnel during each sampling or QA/QC event. The serial number for each datalogger used at each sampling station is documented on field data sheets.

B3 Sampling Handling and Custody

B3.1 Sample Collection Documentation

VRAP requires documentation of activities during data collection. All documentation is described in Sections B3.1.1 and B3.1.2, which ensures sample authenticity and data integrity.

B3.1.1 Field Notes

The field data sheets are tabularized to include, but not limited to: VRAP group, start date, start time, end time, station ID, waterbody name, weather comments, dissolved oxygen, water temperature, specific conductance, pH, turbidity, other field notes, calibration documentation, and meter QA/QC checks. The water quality data and associated comments are retained in individual volunteer group file folders, and the field data sheets are added to the files throughout the sampling season.

The file folders are also used to retain formatted station description forms for documenting the metadata associated with each sampling station, including, but not limited to station ID, water depth, stream width, latitude, and longitude.

B3.1.2 Field Documentation Management System

Field documentation during each sampling year includes water quality data, comments regarding any problems with instrumentation/sampling, and physical attributes of the waterbody at each station. The water quality data and associated comments are retained in individual file folders. The folders also contain station description forms, which are retained indefinitely, and stored at NHDES. The file folders are archived prior to the commencement of the following monitoring season, and retained indefinitely.

B3.2 Sample Handling and Tracking System

All water samples are identified and tracked through documentation on field data sheets (Appendix A-2).

B3.2.1 Field Tasks

Prior to sample collection, all water sample storage containers are labeled in permanent marker with the following information: station identification number/name, date of sample collection, parameter of interest, initials of the volunteer monitor(s), and “split”, “replicate”, etc, as appropriate. Labeling the containers prior to collection augments the legibility of the information, as condensation on the outside of a sample container generally occurs rapidly after water is placed in the container. However, the time of sample collection is written on the label immediately after the sample is collected.

If a replicate sample is taken for in-situ field parameters than the data is entered on the bottom of the field data sheet (Appendix A-2) with “REP” added to the end of the Station ID (i.e. sample ID 02-ISR – replicate 02-ISR REP). If replicate samples are collected for laboratory analysis then “REP” is added to the Station ID on the sample bottles. If a new station is created and sampled, then a station ID is not assigned in the field and instead the volunteers indicate it is a new station on the field data sheet and provide the metadata needed for VRAP staff to create a new station (latitude/longitude, waterbody name, site description, directions to the site, etc.) Upon receipt of the field data sheet with a new station, VRAP staff will communicate with the VRAP group and confirm the metadata associated with the location and create a new station ID for use in the EMD. In addition, station information is entered in to the NHDES Environmental Monitoring Database and GIS coverage for all VRAP sampling stations.

B3.2.2 Laboratory Tasks

This section describes tasks associated with samples analyzed by NH DHHS Public Health Laboratory. Tasks associated with other laboratories are documented in annual SAPs developed by the individual volunteer groups and VRAP staff; the SAPs are retained at the Water Quality Planning Section office. The information recorded on the sampling container, as well as any other comments and/or notes, is transferred to a Login and Custody Sheet at the laboratory. This information is also transferred from the Login and Custody Sheet to the Laboratory Information Management System (LIMS) database, which provides a printed label for each logged sample. The printed label contains all information written on the sample storage container, as well as the login date and time. Water samples are analyzed for parameters listed in Table 11. Any excess sample water is discarded in laboratory sinks, unless otherwise specified in the SOPs in Appendix B.

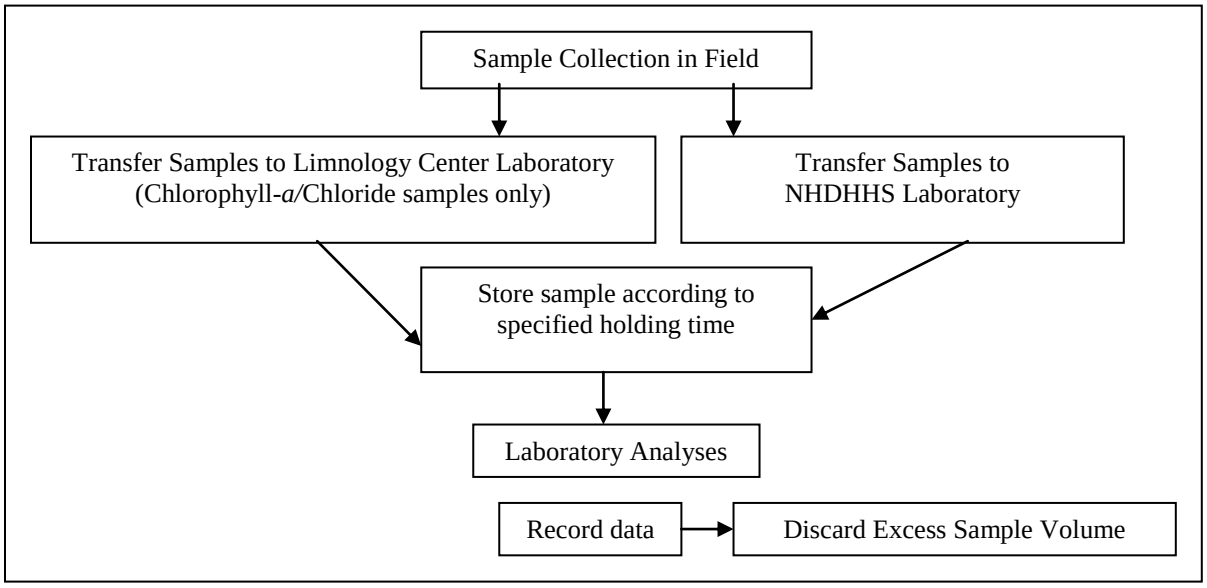
B3.2.3 Sample Custody

Water samples analyzed by the NH DHHS Public Health Laboratory are collected in sample storage containers provided by the Laboratory Services Unit. Water samples analyzed by other laboratories are collected in sample storage containers provided by the specific laboratory; the information is documented in annual SAPs developed by the individual volunteer groups and VRAP staff; the SAPs are retained at the Water Quality Planning Section office. All samples are placed on cubed ice in a portable, opaque cooler immediately after collection, and transported to the laboratory. Samples are transported to the laboratory within the specified holding times of the parameters that were measured (Table 11).

Upon arrival at the NH DHHS Public Health Laboratory, the volunteer monitor is responsible for completing a Login and Custody Sheet supplied by the NH DHHS Public Health Laboratory (Appendix B-1) (Figure 2). The information recorded on the sampling container, as well as any other comments and/or notes, is transferred to the Login and Custody Sheet. Water samples are transferred from the cooler to a refrigerator at the laboratory after appropriate login procedures. However, samples for chlorophyll *a* and chloride are delivered and logged into a database in the NHDES JCLC by VRAP or NHDES JCLC staff. See Table 11 for sample container, volume, preservation information, and holding time information. The volunteer monitor is divested from responsibilities after completing the Login and Custody Sheet.

Laboratory personnel are subsequently responsible for transferring information from the Login and Custody Sheet to the LIMS, which provides a printed label for each logged sample. The label contains all information written on the sample storage container, as well as the login date and time. The time of analysis is dependent on the holding time for the parameter of interest, where analyses are never conducted after the designated holding time expires. Analytical data are subsequently entered into the laboratory database, and printed on laboratory letterhead. Printed results are transmitted to the Program Manager. Excess sample water is discarded in laboratory sinks, unless otherwise specified in the SOPs in Appendix B.

Figure 2. Typical Sampling Handling/Tracking/Custody Summary



B4 Analytical Methods

B4.1 Field Analytical Method Requirements

This section describes the analytical techniques used in the field to generate data for the VRAP program. All field analytical methods and SOPs used to meet measurement performance criteria and achieve project quantification limits are documented in this section.

B4.1.1 Field Analytical Methods and SOPs

Refer to Appendix A for field method SOPs. Refer to Table 13 for a Field Analytical Method/SOP Reference Table.

Table 13. Field Analytical Method/SOP Reference Table

Reference Number (Appendix)	Title, Revision date or number	Analytical parameter	Instrument	Origin of SOP (Organization)	Organization performing field analysis
A-1	VRAP Water Quality Monitoring Field Sampling Protocols for Volunteer Monitors (SOP): April 2016	Water Temperature	Electronic meter	YSI Incorporated	Volunteers NHDES
		Dissolved Oxygen	Electronic meter	YSI Incorporated	
		pH	Electronic meter	Oakton Instruments.	
		Specific Conductance	Electronic meter	YSI Incorporated	
		Turbidity	Electronic meter	Lamotte Company	
A-10	VRAP SOP for Stream Flow Determination and Temporary Staff Gages: April 2010	Water Depth	Electronic Meter	Marsh-McBirney, Inc.	Volunteers NHDES
		Velocity	Electronic Meter	Marsh-McBirney, Inc.	
A-3	VRAP SOP for InSitu Troll 9500: April 2009	Temperature, Dissolved Oxygen; pH; Specific Conductance; Turbidity	Electronic submersible multiprobe	In-Situ	Volunteers NHDES
A-5	VRAP SOP for YSI 6000 XLM Multiprobe: May 2006	Temperature, Dissolved Oxygen; pH; Specific Conductance; Turbidity	Electronic submersible multiprobe	YSI	Volunteers NHDES
A-7	VRAP SOP for YSI EXO1 and EXO2: April 2017	Temperature, Dissolved Oxygen; pH; Specific Conductance; Turbidity	Electronic submersible multiprobe	YSI	Volunteers NHDES
A-9	VRAP SOP for OnSet HOBO U22 Water Temp Pro: April 2009	Water Temperature	Electronic submersible probe	Onset	Volunteers NHDES

A-11	VRAP SOP for OnSet HOBO U24 Conductivity Logger: April 2009/May 2017	Water Temperature, and Specific Conductance	Electronic submersible multiprobe	Onset	Volunteers NHDES
A-12	VRAP SOP for OnSet HOBO U20 Water Level Logger: April 2009	Water Level	Electronic submersible probe	Onset	Volunteers NHDES

B4.1.2 Field Analytical Method/SOP Modification

Modifications to the field analytical methods or SOPs are anticipated during the five-year term of this QAPP, based on practical experience gained in the field and changes in available instrumentation. Modifications are approved by the Program Manager and are documented in annual VRAP workplans. Standard operating procedures may be added for new instrumentation during any given sampling year. In this case, the SOPs for the new instrumentation are provided in annual updates to the "VRAP Water Quality Monitoring Field Sampling Protocols for Volunteer Monitors" and incorporated into the annual VRAP training workshops. In addition, modifications are documented through annual VRAP Self-Audits, which are required pursuant to the NHDES QMP.

B4.2 Fixed Analytical Method Requirements

This section describes the analytical techniques used by the NH DHHS Public Health Laboratory, and the NHDES NHDES JCLC to generate data for VRAP. Methods are analytical techniques used to identify and quantify the target analytes. Analytical SOPs document how the laboratory will perform a specific analytical method.

B4.2.1 Fixed Laboratory Analytical Method/SOP Reference Table

All samples collected for laboratory analysis through the VRAP program are transported to the NH DHHS Public Health Laboratory, the NHDES NHDES JCLC, or local Wastewater Treatment Facilities for analysis. The laboratories use various analytical instruments and associated SOPs, referenced in Table 14, below. A summary of methods is also provided in Table 14. Sample custody, data documentation, and data management procedures are described in Section B3.2 of this QA Project Plan.

Table 14. Fixed Laboratory Analytical Method/SOP Reference Table

Analytical parameter	Reference Number (Appendix)	SOP Title and Revision Date/Number Name of Laboratory	Instrument
E. coli	B-14	State of NH Environmental Services Laboratory: *E. coli* by membrane filtration Revision No. 1.8 Revision Date: 3-25-08	Membrane Filter assembly
Chlorophyll *a*	B-17	State of NH Limnology Center Laboratory: Chlorophyll *a* Revision No. 1.2 Revision Date: 7-7-03 (in NHDES Limnology Center Laboratory Manual May 20, 2007)	Spectrophotometer
Chloride (Cl)	B-5	State of NH Environmental Services Laboratory: Lachat Flow Injection Anions: Nitrate, Nitrite, Chloride, and	Lachat Flow Injection Analyzer

Analytical parameter	Reference Number (Appendix)	SOP Title and Revision Date/Number Name of Laboratory	Instrument
		Fluoride (automated Nitrite) Revision No. 2.7 Revision Date: 2-19-08	
	B-20	State of NH Limnology Center Laboratory: Orion Star ISE Meter Revision No.1.3 Revision Data: 05/01/10	Orion Star Ion Specific Electrode
Total Phosphorus (TP)	B-4	State of NH Environmental Services Laboratory: Total Phosphorus, Lachat Flow Injection Colorimetry Revision No. 2.6 Revision Date: 2-8-08	Lachat Flow Injection Analyzer
	B-21	PSU Environmental Research Laboratory Lachat QuickChem Auto Analyzer Revision No. 1.2 Revision Date: 2-5-07	Lachat Auto Analyzer
Dissolved Ortho Phosphorus (DOP)	B-3	State of NH Environmental Services Laboratory: Ortho Phosphorus; Revision No 2.4; Date: 2-8-08	Lachat Flow Injection Analyzer
Nitrate/Nitrite (NO_3+NO_2)	B-5	State of NH Environmental Services Laboratory: Lachat Flow Injection Anions: Nitrate, Nitrite, Chloride, and Fluoride (automated Nitrite) Revision No. 2.7 Revision Date: 2-19-08	Lachat Flow Injection Analyzer
Total Kjeldahl Nitrogen (TKN)	B-7	State of NH Environmental Services Laboratory: Total Kjeldahl Nitrogen, TKN by flow injection colorimetry Revision No. 2.8 Revision Date: 8-3-07	Lachat Flow Injection Analyzer
Ammonia (NH_3)	B-8	State of NH Environmental Services Laboratory: Ammonia by flow injection colorimetry Revision No. 2.7 Revision Date: 2-11-08	Lachat Flow Injection Analyzer
Biological Oxygen Demand (BOD_5)	B-9	State of NH Environmental Services Laboratory: Biochemical oxygen demand Revision No. 3.1 Revision Date: 1-25-08	Membrane electrode
Alkalinity	B-11	State of NH Environmental Services Laboratory: Alkalinity Revision No. 5.6 Revision Date: 1-25-08	pH Meter- Orion 710A and Brinkman Digital Buret
Total Solids (TS)	B-12	State of NH Environmental Services Laboratory: Total Residue Revision No. 2.0 Revision Date: 2-26-08	Gooches, drying oven, analytical balance
Total Suspended Solids (TSS)	B-13	State of NH Environmental Services Laboratory: Total non-filterable residue (suspended solids) Revision No. 2.2 Revision Date: 2-26-08	Gooches, drying oven, analytical balance
Total Organic Carbon (TOC)	B-2	State of NH Environmental Services Laboratory: Total Organic Carbon; Revision No 1.8; Date: 6-10-08	Teledyne Tekmar Fusion TOC analyzer

Analytical parameter	Reference Number (Appendix)	SOP Title and Revision Date/Number Name of Laboratory	Instrument
Sulfate (SO_4)	B-6	State of NH Environmental Services Laboratory: Sulfate by Lachat Ion Chromatography; Revision No: 1.2; Date: 1-28-08	Lachat Flow Injection Analyzer
Calcium (Ca)	B-10	State of NH Environmental Services Laboratory: Metals by ICP, EPA 200.7; Revision No: 2.6; Date: 3-11-08	ICP
Magnesium (Mg)	B-10	State of NH Environmental Services Laboratory: Metals by ICP, EPA 200.7; Revision No: 2.6; Date: 3-11-08	ICP
Potassium (K)	B-10	State of NH Environmental Services Laboratory: Metals by ICP, EPA 200.7; Revision No: 2.6; Date: 3-11-08	ICP
Sodium (Na)	B-10	State of NH Environmental Services Laboratory: Metals by ICP, EPA 200.7; Revision No: 2.6; Date: 3-11-08	ICP
Hardness	B-10	State of NH Environmental Services Laboratory: Metals by ICP for public drinking water Revision No. 2.6 Revision Date: 03-11-08	ICP
Aluminum (Al)	B-10	State of NH Environmental Services Laboratory: Metals by ICP for public drinking water Revision No. 2.6 Revision Date: 3-11-08	ICP
Copper (Cu)	B-10; B-16	State of NH Environmental Services Laboratory: Metals by ICP-MS for public drinking water Revision No. 1.0 Revision Date: 2-29-08	ICP-MS
Lead (Pb)	B-10, B16	State of NH Environmental Services Laboratory: Metals by ICP-MS for public drinking water Revision No. 1.0 Revision Date: 2-29-08	ICP-MS
Zinc (Zn)	B-10	State of NH Environmental Services Laboratory: Metals by ICP-MS for public drinking water Revision No: 2.6 Date: 3-11-08	ICP

B4.2.2 Fixed Laboratory Analytical Method/SOP Modifications

Modifications to the laboratory analytical methods or SOPs may occur during the five-year term of this QAPP, based on practical experience gained in the laboratory. Modifications are made by the Laboratory QA Manager. Modifications are documented in a revised analytical method or SOP, retained by the Laboratory QA Manager.

B4.3 Specific Performance Requirements

For specific performance requirements for each analyte of concern, refer to Tables 15 through 39.

B5 Quality Control

This section of the QAPP documents the QC procedures, checks, samples, and acceptance limits used for the VRAP program.

B5.1 Sampling Quality Control

Quality control for field sampling consists of collecting replicate samples. A replicate sample is described as the same bucket of water being measured again for field parameters and two sets of bottles filled from the same bucket for laboratory parameters. As described in Section B2 of this QAPP, VRAP typically uses a bucket of known volume (*e.g.*, two-gallon) to collect a water sample.

Prior to collection of the sample, the bucket is rinsed three times with water from the waterbody. The bucket is then immersed and filled with as much as possible without causing agitation. The bucket is then hoisted from the waterbody and appropriate sample volumes are subsequently poured into two sets of respective sample bottles for laboratory analysis. One set of bottles represents the original sample and the second set of samples constitutes the replicate sample. Once both the original sample and replicate bottles are filled, field measurements are taken with handheld meters. Replicate field measurements are then taken after all necessary volumes are poured from the bucket into the sample bottles, and after the field instruments are recalibrated and rinsed.

Replicate measurements/samples are made/collected at minimum after every 10^{th} original sample or measurement (*i.e.*, 10%). However, each VRAP group is required to take at least one replicate for field measurements during each sampling day and for each team sampling regardless of the number of stations sampled.

Upon arrival at the NH DHHS Public Health Laboratory, the VRAP staff or a laboratory staff member measures the temperature of the water sample using an infrared thermometer and records the temperature on the Login and Custody Sheet. The Program Manager accepts laboratory results only if the sample temperature upon receipt at the laboratory approximates the requisite parameter-specific storage temperature (e.g., 1-6^{o}C), or a short time span existed between sample collection and sample receipt to preclude acclimation to the requisite parameter-specific storage temperature. The Program Manager consults the Laboratory QA Manager if necessary.

B5.2 Analytical Quality Control

This section of the QAPP identifies the QC procedures, checks, and samples, and their respective acceptance limits that will be used during the project

B5.2.1 Field Analytical QC

Field replicate measurements are made for all parameters, as described in Section B5-1, above (Table 15). Turbidity, specific conductance, and pH measurements are verified through comparisons with known buffers (e.g., pH = 6.0). Dissolved oxygen measurements are verified by comparing the percent of saturation value appropriate to the sampling station with the actual percent of saturation value following calibration. Data retention for water quality assessment purposes is contingent on compliance with a parameter-specific absolute and relative percent differences described in Section A7 of this QAPP.

Table 15. Field Analytical QC Sample Table

Water Quality Parameter	QC Check[a]	QC Acceptance Limit	Corrective Action	Person Responsible for Corrective Action	Data Quality Indicator
Dissolved Oxygen	Measurement replicate	RPD ≤ 10% or ABS ≤ 0.4 mg/l or ≤ 4%	Recalibrate instrument, repeat measurement	Volunteers; VRAP Staff	Precision
	Initial Calibration Value	± 5.0% of calibration saturation	Recalibrate instrument, repeat measurement	Volunteers; VRAP Staff	Accuracy
Temperature	Measurement replicate	RPD ≤ 10 %	Repeat measurement	Volunteers; VRAP Staff	Precision
pH	Measurement replicate	ABS ≤ 0.3 std units	Recalibrate instrument, repeat measurement	Volunteers; VRAP Staff	Precision
	Known buffer Initial Calibration Value (e.g., pH = 6.0)	± 0.3 std units	Recalibrate instrument repeat measurement	Volunteers; VRAP Staff	Accuracy
Specific Conductance	Measurement replicate	RPD ≤ 10% or ABS ≤ 25 µS/cm	Recalibrate instrument, repeat measurement	Volunteers; VRAP Staff	Precision
	ICV (e.g., 100 µS/cm)	± 25.0 µS/cm	Recalibrate instrument, repeat measurement	Volunteers; VRAP Staff	Accuracy
Turbidity	Measurement replicate	ABS ≤ 1.0 NTU	Recalibrate instrument, repeat measurement	Volunteers; VRAP Staff	Precision
	Field blank	± 0.1 NTU	Recalibrate instrument, repeat measurement	Volunteers; VRAP Staff	Accuracy
Water Depth	Measurement replicate	RPD ≤ 10%	Zero Check Instrument; repeat measurement	Volunteers; VRAP Staff	Precision
Velocity	Measurement replicate	RPD ≤ 10%	Zero Check Instrument; repeat measurement	Volunteers; VRAP Staff	Precision

B5.2.2 Fixed Laboratory QC

Laboratory QC is achieved through various checks, as summarized in Table 16 through Table 39. Complete descriptions, including acceptance criteria, are provided in parameter-specific SOPs in Appendix B. Precision calculations in the laboratory are derived from duplicate sample analysis, where duplicate sample frequency varies according to analyte (*e.g.*, one duplicate for every 10 total phosphorus samples). Precision is expressed as ranges (i.e., calculation of difference between actual sample and duplicate sample).

Table 16. Laboratory Analytical QC - NHDES VRAP Program: Total Organic Carbon (TOC)

Analytical Method/SOP Reference: Appendix B-2		**Measurement Performance Criteria: O.I. Analytical 1020A; SM 5310B**		**Number of Samples: TBD[a]**	
Laboratory QC:	**Frequency/ Number**	**Method/SOP QC Acceptable Limits[b]**	**Corrective Action (CA)**	**Person(s) Responsible For CA**	**Data Quality Indicator (DQI)**
Method Blank	NA	None	None	None	None
Reagent Blank	1 per batch of 20	<0.35 mg TOC/L	Invalidate the run and repeat	Analyst, Inorganic Supervisor, Quality Control Supervisor	Contamination, drift, method performance
Instrument Blank	NA	None	None	None	None
Laboratory Matrix Spike	1 every 10 samples	70-130%	Repeat, qualify data	Analyst, Inorganic Supervisor, Quality Control Supervisor	Matrix effect
Laboratory Control Sample (Independent Calibration Verification)	1 per batch of 20	80-102%	Repeat run or section	Analyst, Inorganic Supervisor, Quality Control Supervisor	Accuracy
Laboratory Fortified Blank	1 every 10 samples	80-120%	Repeat run	Analyst, Inorganic Supervisor, Quality Control Supervisor	Accuracy, method performance
Continuing Calibration Verification	Every 10 and at end of batch Low CCC, 1 per 20 High CCC, 1 per 20	80-120% mid CCC Low 50-150% High 85-115%	Repeat run or section	Analyst, Inorganic Supervisor, Quality Control Supervisor	Drift

[a]to be determined and documented in annual sampling and analysis plans
[b]subject to change annually; changes documented in annual sampling and analysis plans

Table 17. Laboratory Analytical QC - NHDES VRAP Program: Dissolved Ortho Phosphorus (DOP)

Analytical Method/SOP Reference: Appendix B-3		**Measurement Performance Criteria: Lachat 10-115-01-1-B**		**Number of Samples: TBD[a]**	
Laboratory QC:	**Frequency/ Number**	**Method/SOP QC Acceptable Limits[b]**	**Corrective Action (CA)**	**Person(s) Responsible For CA**	**Data Quality Indicator (DQI)**
Method Blank	1 at beginning, end and every 10 samples	<80% RDL	Invalidate the run and repeat	Analyst, Inorganic Supervisor, Quality Control Supervisor	Contamination, drift, method performance
Reagent Blank	N/A	None	None	None	None
Instrument Blank	NA	None	None	None	None
Matrix Spike Duplicate	1 every 10 samples	±9% RPD	Re-analyze spike set , qualify data	Analyst, Inorganic Supervisor, Quality Control Supervisor	Precision
Laboratory Matrix Spike	1 every 10 samples	83-109%	Re-analyze spike set , qualify data	Analyst, Inorganic Supervisor, Quality Control Supervisor	Matrix effect
Laboratory Control Sample (Independent Calibration Verification)	1 per batch of 20	95-105%	Repeat run	Analyst, Inorganic Supervisor, Quality Control Supervisor	Accuracy
Laboratory Fortified Blank	1/run	87-114%	Repeat run	Analyst, Inorganic Supervisor, Quality Control Supervisor	Accuracy, method performance
Continuing Calibration Verification	1 every 10 samples	90-110%	Re-analyze samples back to last acceptable CCV	Analyst, Inorganic Supervisor, Quality Control Supervisor	Drift

[a]to be determined and documented in annual sampling and analysis plans
[b]subject to change annually; changes documented in annual sampling and analysis plans

Table 18. Laboratory Analytical QC - NHDES VRAP Program: Total Phosphorous (TP)

Analytical Method/SOP Reference: Appendix B-4		**Measurement Performance Criteria: EPA 365.2 by Lachat 10-115-01-1-F**		**Number of Samples: TBD[a]**	
Laboratory QC:	**Frequency/ Number**	**Method/SOP QC Acceptable Limits[b]**	**Corrective Action (CA)**	**Person(s) Responsible For CA**	**Data Quality Indicator (DQI)**
Method Blank	1 at beginning, end and every 10 samples	<80% RDL	Invalidate the run and repeat	Analyst, Inorganic Supervisor, Quality Control Supervisor	Contamination, drift, method performance
Reagent Blank	NA	None	None	None	None
Instrument Blank	NA	None	None	None	None
Matrix Spike Duplicate	1 every 10 samples	±5% RPD	Re-analyze spike set , qualify data	Analyst, Inorganic Supervisor, Quality Control Supervisor	Precision
Laboratory Matrix Spike	1 every 10 samples	90-109%	Re-analyze spike set , qualify data	Analyst, Inorganic Supervisor, Quality Control Supervisor	Matrix effect
Laboratory Control Sample (Independent Calibration Verification)	1 per batch of 20	92-104%	Repeat run	Analyst, Inorganic Supervisor, Quality Control Supervisor	Accuracy
Laboratory Fortified Blank	1/run	91-102%	Repeat run	Analyst, Inorganic Supervisor, Quality Control Supervisor	Accuracy, method performance
Continuing Calibration Verification	1 every 10 samples	90-110%	Re-analyze samples back to last acceptable CCV	Analyst, Inorganic Supervisor, Quality Control Supervisor	Drift

[a]to be determined and documented in annual sampling and analysis plans
[b]subject to change annually; changes documented in annual sampling and analysis plans

Table 19. Laboratory Analytical QC - NHDES VRAP Program: Nitrate and Nitrite ($NO_3 + NO_2$)

Analytical Method/SOP Reference: Appendix B-5		**Measurement Performance Criteria: EPA 340.2 by Lachat 10-107-04-1-A**		**Number of Samples: TBD[a]**	
Laboratory QC:	**Frequency/ Number**	**Method/SOP QC Acceptable Limits[b]**	**Corrective Action (CA)**	**Person(s) Responsible For CA**	**Data Quality Indicator (DQI)**
Method Blank	1 at beginning, end and every 10 samples	<80% RDL	Invalidate the run and repeat	NA	NA
Reagent Blank	NA	None	None	None	None
Instrument Blank	NA	None	None	None	None
Matrix Spike Duplicate	1 every 10 samples	±9% RPD	Re-analyze spike set , qualify data	Analyst, Inorganic Supervisor, Quality Control Supervisor	Precision
Laboratory Matrix Spike	1 every 10 samples	90-110%	Re-analyze spike set , qualify data	Analyst, Inorganic Supervisor, Quality Control Supervisor	Matrix interference
Laboratory Control Sample (Independent Calibration Verification)	1 per batch of 20	90-110%	Repeat run	Analyst, Inorganic Supervisor, Quality Control Supervisor	Accuracy
Laboratory Fortified Blank	1/run	90-110%	Repeat run	Analyst, Inorganic Supervisor, Quality Control Supervisor	Method Performance/ Accuracy
Continuing Calibration Verification	1 every 10 samples	90-110%	Re-analyze samples back to last acceptable CCV	Analyst, Inorganic Supervisor, Quality Control Supervisor	Method Performance/ Accuracy

[a]to be determined and documented in annual sampling and analysis plans
[b]subject to change annually; changes documented in annual sampling and analysis plans

Table 20. Laboratory Analytical QC - NHDES VRAP Program: Chloride (Cl)

Analytical Method/SOP Reference: Appendix B-5		**Measurement Performance Criteria: EPA 340.2 by Lachat 10-117-07-1-B**		**Number of Samples: TBD[a]**	
Laboratory QC:	**Frequency/ Number**	**Method/SOP QC Acceptable Limits[b]**	**Corrective Action (CA)**	**Person(s) Responsible For CA**	**Data Quality Indicator (DQI)**
Method Blank	1 at beginning, end and every 10 samples	<80% RDL	Invalidate the run and repeat	None	None
Reagent Blank	NA	None	None	None	None
Instrument Blank	NA	None	None	None	None
Matrix Spike Duplicate	1 every 10 samples	±7% RPD	Re-analyze spike set , qualify data	Analyst, Inorganic Supervisor, Quality Control Supervisor	Precision
Laboratory Matrix Spike	1 every 10 samples	88-114%	Re-analyze spike set , qualify data	Analyst, Inorganic Supervisor, Quality Control Supervisor	Matrix interference
Laboratory Control Sample (Independent Calibration Verification)	1 per batch of 20	95-107%	Repeat run	Analyst, Inorganic Supervisor, Quality Control Supervisor	Accuracy
Laboratory Fortified Blank	1/run	95-108%	Repeat run	Analyst, Inorganic Supervisor, Quality Control Supervisor	Method Performance/ Accuracy
Continuing Calibration Verification	1 every 10 samples	90-110%	Re-analyze samples back to last acceptable CCV	Analyst, Inorganic Supervisor, Quality Control Supervisor	Method Performance/ Accuracy

[a]to be determined and documented in annual sampling and analysis plans
[b]subject to change annually; changes documented in annual sampling and analysis plans

Table 21. Laboratory Analytical QC - NHDES VRAP Program: Sulfate (SO_4)

Analytical Method/SOP Reference: Appendix B-6		**Measurement Performance Criteria: Lachat Quik Chem Method 10-511-00-1-A**		**Number of Samples: TBD[a]**	
Laboratory QC:	**Frequency/ Number**	**Method/SOP QC Acceptable Limits[b]**	**Corrective Action (CA)**	**Person(s) Responsible For CA**	**Data Quality Indicator (DQI)**
Method Blank	1 at beginning, end and every 10 samples	<70% RDL	Invalidate the run and repeat	Analyst, Inorganics Supervisor, QAO	Contamination, drift
Reagent Blank	None	None	None	None	None
Instrument Blank	None	None	None	None	None
Matrix Spike Duplicate	1 every 10 samples	±8% RPD	Re-analyze spike set , qualify data	Analyst, Inorganics Supervisor, QAO	Precision
Laboratory Matrix Spike	1 every 10 samples	90-110%	Re-analyze spike set , qualify data	Analyst, Inorganics Supervisor, QAO	Matrix effects
Laboratory Control Sample (Independent Calibration Verification)	1 per batch of 20	85-115%	Repeat run	Analyst, Inorganics Supervisor, QAO	Accuracy
Laboratory Fortified Blank	1/run	89-105%	Repeat run	Analyst, Inorganic Supervisor, Quality Control Supervisor	Method Performance/Accuracy

[a]to be determined and documented in annual sampling and analysis plans
[b]subject to change annually; changes documented in annual sampling and analysis plans

Table 22. Laboratory Analytical QC - NHDES VRAP Program: Total Kjeldahl Nitrogen (TKN)

Analytical Method/SOP Reference: Appendix B-7		**Measurement Performance Criteria: EPA 351.2 by Lachat 10-107-06-2-E**		**Number of Samples: TBD[a]**	
Laboratory QC:	**Frequency/ Number**	**Method/SOP QC Acceptable Limits[b]**	**Corrective Action (CA)**	**Person(s) Responsible For CA**	**Data Quality Indicator (DQI)**
Method Blank	1 at beginning, end and every 10 samples	<80% RDL	Invalidate the run and repeat	Analyst, Inorganic Supervisor, Quality Control Supervisor	Contamination, method performance, drift
Reagent Blank	NA	None	None	None	None
Instrument Blank	NA	None	None	None	None
Matrix Spike Duplicate	1 every 10 samples	±18% RPD	Re-analyze spike set , qualify data	Analyst, Inorganic Supervisor, Quality Control Supervisor	Precision
Laboratory Matrix Spike	1 every 10 samples	90-110%	Re-analyze spike set , qualify data	Analyst, Inorganic Supervisor, Quality Control Supervisor	Matrix /effect
Laboratory Control Sample (Independent Calibration Verification)	1 per batch of 20	90-110%	Repeat run	Analyst, Inorganic Supervisor, Quality Control Supervisor	Accuracy
Laboratory Fortified Blank	1/run	90-110%	Repeat run	Analyst, Inorganic Supervisor, Quality Control Supervisor	Accuracy and method performance
Continuing Calibration Verification	1 every 10 samples	90-110%	Re-analyze samples back to last acceptable CCV	Analyst, Inorganic Supervisor, Quality Control Supervisor	Accuracy and method performance

[a]to be determined and documented in annual sampling and analysis plans
[b]subject to change annually; changes documented in annual sampling and analysis plans

Table 23. Laboratory Analytical QC - NHDES VRAP Program: Ammonia (NH_3)

Analytical Method/SOP Reference: Appendix B-8		**Measurement Performance Criteria: Standard Methods # 4500NH3-B.& G**		**Number of Samples: TBD[a]**	
Laboratory QC:	**Frequency/ Number**	**Method/SOP QC Acceptable Limits[b]**	**Corrective Action (CA)**	**Person(s) Responsible For CA**	**Data Quality Indicator (DQI)**
Method Blank	1 at beginning, end and every 10 samples	<80% RDL	Invalidate the run and repeat	Analyst, Inorganic Supervisor, Quality Control Supervisor	Method performance contamination drift
Reagent Blank	NA	None	None	None	None
Instrument Blank	NA	None	None	None	None
Matrix Spike Duplicate	1 every 10 samples	±23% RPD	Re-analyze spike set , qualify data	Analyst, Inorganic Supervisor, Quality Control Supervisor	Precision
Laboratory Matrix Spike	1 every 10 samples	90-110%	Re-analyze spike set , qualify data	Analyst, Inorganic Supervisor, Quality Control Supervisor	Matrix effects (interference)
Laboratory Control Sample (Independent Calibration Verification)	1 per batch of 20	90-110%	Repeat run	Analyst, Inorganic Supervisor, Quality Control Supervisor	Accuracy
Laboratory Fortified Blank	1/run	90-110%	Repeat run	Analyst, Inorganic Supervisor, Quality Control Supervisor	Accuracy and methods performance
Continuing Calibration Verification	1 every 10 samples	90-110%	Re-analyze samples back to last acceptable CCV	Analyst, Inorganic Supervisor, Quality Control Supervisor	Accuracy and methods performance

[a]to be determined and documented in annual sampling and analysis plans
[b]subject to change annually; changes documented in annual sampling and analysis plans

Table 24. Laboratory Analytical QC - NHDES VRAP Program: Biochemical Oxygen Demand (BOD5)

Analytical Method/SOP Reference: Appendix B-9		**Measurement Performance Criteria: Standard Methods # 5210B**		**Number of Samples: TBD[a]**	
Laboratory QC:	**Frequency/ Number**	**Method/SOP QC Acceptable Limits[b]**	**Corrective Action (CA)**	**Person(s) Responsible For CA**	**Data Quality Indicator (DQI)**
Method Blank (Unseeded and Seeded)	1/batch	Unseeded ≤0.2 mg/L Seeded 0.6-1.0 mg/L	Report qualified data	Analyst, Inorganic Supervisor, Quality Control Supervisor	None
Blank (Dilution Water)	NA	None	None	None	None
Instrument Blank	NA	None	None	None	None
Matrix Spike Duplicate	1/batch	±9% RPD	Report qualified data	Analyst, Inorganic Supervisor, Quality Control Supervisor	Precision
Laboratory Matrix Spike	1/batch per matrix	81-132%	Report qualified data	Analyst, Inorganic Supervisor, Quality Control Supervisor	Interferences
Laboratory Control Sample (Independent Calibration Verification)	1/batch of 20	95-118%	Report qualified data or invalidate data	Analyst, Inorganic Supervisor, Quality Control Supervisor	Accuracy
Laboratory Fortified Blank	See laboratory control sample	See laboratory control sample	See laboratory control sample	See laboratory control sample	See laboratory control sample

[a]to be determined and documented in annual sampling and analysis plans
[b]subject to change annually; changes documented in annual sampling and analysis plans

Table 25. Laboratory Analytical QC - NHDES VRAP Program: Hardness

Analytical Method/SOP Reference: Appendix B-10		**Measurement Performance Criteria: EPA 200.7**		**Number of Samples: TBD[a]**	
Laboratory QC:	**Frequency/ Number**	**Method/SOP QC Acceptable Limits[b]**	**Corrective Action (CA)**	**Person(s) Responsible For CA**	**Data Quality Indicator (DQI)**
Method Blank	1 at beginning, end and every 10 samples	<80% RDL	Invalidate data repeat run	Analyst, Inorganic Supervisor, Quality Control Supervisor	Method performance contamination drift
Reagent Blank	1 at beginning of run	None	Look for cause of contamination, qualify data or re-run	None	None
Instrument Blank	NA	None	None	None	None
Matrix Spike Duplicate	1 in 20 samples spiked in duplicate	≤4.4%RPD	Repeat sample or qualify data	analyst, Inorganics supervisor, QAO	Precision
Laboratory Matrix Spike	1 in 10 samples spiked	70-130%	Repeat sample or qualify data	analyst, Inorganics supervisor, QAO	Matrix effects
Laboratory Control Sample (Independent Calibration Verification) (Ca+Mg)	1 per run	90-110%	Re-cal, Re-run	Analyst, Inorganics supervisor, QAO	Accuracy
Laboratory Fortified Blank	1 per run	85-115%	Re-cal, Re-run	Analyst, Inorganics supervisor, QAO	Method Performance

[a]to be determined and documented in annual sampling and analysis plans
[b]subject to change annually; changes documented in annual sampling and analysis plans

Table 26. Laboratory Analytical QC - NHDES VRAP Program: Alkalinity

Analytical Method/SOP Reference: Appendix B-11		**Measurement Performance Criteria: EPA 600/4-79-020, Method 310.1; Standard Method 2320 B (APHA, 1995)**		**Number of Samples: TBD[a]**	
Laboratory QC:	**Frequency/ Number**	**Method/SOP QC Acceptable Limits[b]**	**Corrective Action (CA)**	**Person(s) Responsible For CA**	**Data Quality Indicator (DQI)**
Method Blank (none; part of titration calculation)	NA	None	None	None	None
Reagent Blank	None	None	None	None	None
Instrument Blank	NA	None	None	None	None
Laboratory Duplicates	1 in 10 samples duplicated	≤10%RPD	repeat sample	analyst, Inorganics supervisor, QAO	precision
Laboratory Matrix Spike	NA	None	None	None	None
Laboratory Control Sample (Independent Calibration Verification)	beginning and every 10 samples	98-104%	Re-cal, Re-run	analyst, Inorganics supervisor, QAO	accuracy
Laboratory Fortified Blank	NA	None	None	None	None

[a]to be determined and documented in annual sampling and analysis plans
[b]subject to change annually; changes documented in annual sampling and analysis plans

Table 27. Laboratory Analytical QC - NHDES VRAP Program: Total Solids (TS)

Analytical Method/SOP Reference: Appendix B-12		**Measurement Performance Criteria: EPA 600/4-79-020, Method 160.3; Standard Method 2540 B (APHA, 1995)**		**Number of Samples: TBD[a]**	
Laboratory QC:	**Frequency/ Number**	**Method/SOP QC Acceptable Limits[b]**	**Corrective Action (CA)**	**Person(s) Responsible For CA**	**Data Quality Indicator (DQI)**
Method Blank	1 per run, in	±2.5 mg/L	Report blank with sample result. No blank correction.	analyst, Inorganics supervisor, QAO	drying effectiveness, method performance
Reagent Blank	NA	None	None	None	None
Instrument Blank	NA	None	None	None	None
Laboratory Duplicates	1 per 10 samples duplicated	46% RPD	repeat sample **or** qualify data	analyst, Inorganics supervisor, QAO	precision
Laboratory Matrix Spike	NA	None	None	None	None
Laboratory Control Sample (Independent Calibration Verification)-level varies per lot	1 per batch of 20 samples	77-121%	Re-analyze samples if possible or qualify data	analyst, Inorganics supervisor, QAO	accuracy
Laboratory Fortified Blank	NA	None	None	None	None

[a]to be determined and documented in annual sampling and analysis plans
[b]subject to change annually; changes documented in annual sampling and analysis plans

Table 28. Laboratory Analytical QC - NHDES VRAP Program: Total Suspended Solids (TSS)

Analytical Method/SOP Reference: Appendix B-13		**Measurement Performance Criteria: Standard Methods 2540 D**		**Number of Samples: TBD[a]**	
Laboratory QC:	**Frequency/ Number**	**Method/SOP QC Acceptable Limits[b]**	**Corrective Action (CA)**	**Person(s) Responsible For CA**	**Data Quality Indicator (DQI)**
Method Blank (reported with sample)	1 per run, in	±3 mg/L	Report blank with sample result. No blank correction.	analyst, Inorganics supervisor, QAO	drying effectiveness, method performance
Reagent Blank	NA	None	None	None	None
Instrument Blank	NA	None	None	None	None
Laboratory Duplicates	1 per 10 samples duplicated	70% RPD	repeat sample **or** qualify data	analyst, Inorganics supervisor, QAO	precision
Laboratory Matrix Spike	NA	None	None	None	None
Laboratory Control Sample (Independent Calibration Verification) - level varies per lot	1 per batch of 20 samples	81-109%	Re-analyze samples if possible or qualify data	analyst, Inorganics supervisor, QAO	accuracy
Laboratory Fortified Blank	NA	None	None	None	None

[a]to be determined and documented in annual sampling and analysis plans
[b]subject to change annually; changes documented in annual sampling and analysis plans

Table 29. Laboratory Analytical QC - NHDES VRAP Program: *E. coli*

Analytical Method/SOP Reference: Appendix B-14, B-15		**Measurement Performance Criteria: Membrane Filter Procedure, EPA 600/4-85/076; Standard Method 9213D.3 (APHA, 1995)**		**Number of Samples: TBD[a]**	
Laboratory QC:	**Frequency/ Number**	**Method/SOP QC Acceptable Limits[b]**	**Corrective Action (CA)**	**Person(s) Responsible For CA**	**Data Quality Indicator (DQI)**
Method Blank See Sterility Check	beginning, end, every 10 samples	No growth	request resamples	microbiology supervisor, QAO	contamination
Reagent Blank	NA	None	None	None	None
Instrument Blank	NA	None	None	None	None
Sterility Check Control same as Method Blank	Beginning, middle, end with each batch of samples	No growth	request resamples	microbiology supervisor, QAO	contamination
Positive Control	Prior to Media being used	Positive	Investigate cause; make new media	microbiology supervisor, QAO	Inadequate media
Laboratory Duplicates	every 10 samples	not established	None	None	precision
Laboratory Matrix Spike	NA	None	None	None	None
Laboratory Control Sample (Independent Calibration Verification)	NA	None	None	None	None
Laboratory Fortified Blank	NA	None	None	None	None

[a]to be determined and documented in annual sampling and analysis plans
[b]subject to change annually; changes documented in annual sampling and analysis plans

Table 30. Laboratory Analytical QC - NHDES VRAP Program: Aluminum (Al)

Analytical Method/SOP Reference: Appendix B-10		**Measurement Performance Criteria: EPA 200.7**		**Number of Samples: TBD[a]**	
Laboratory QC:	**Frequency/ Number**	**Method/SOP QC Acceptable Limits[b]**	**Corrective Action (CA)**	**Person(s) Responsible For CA**	**Data Quality Indicator (DQI)**
Method Blank	1 at beginning, end and every 10 samples	<80% RDL	Invalidate data repeat run	analyst, Inorganics supervisor, QAO	contamination, drift
Reagent Blank	1 at beginning of run	None	Look for cause of contamination, qualify data or re-run	None	None
Instrument Blank	NA	None	None	None	None
Matrix Spike Duplicate	1 in 20 samples spiked in duplicate	≤6%RPD	repeat sample **or** qualify data	analyst, Inorganics supervisor, QAO	precision
Laboratory Matrix Spike	1 in 10 samples spiked	70-130%	repeat sample **or** qualify data	analyst, Inorganics supervisor, QAO	matrix effects
Laboratory Control Sample (Independent Calibration Verification) (Ca+Mg)	1 per run	88-106%	Re-cal, Re-run	analyst, Inorganics supervisor, QAO	accuracy
Laboratory Fortified Blank	1 per run	85-115%	Re-cal, Re-run	analyst, Inorganics supervisor, QAO	method performance

[a]to be determined and documented in annual sampling and analysis plans
[b]subject to change annually; changes documented in annual sampling and analysis plans

Table 31. Laboratory Analytical QC - NHDES VRAP Program: Calcium (Ca)

Analytical Method/SOP Reference: Appendix B-10		**Measurement Performance Criteria: EPA 200.7 by Spectro Ciros CCD ICP; SM 2340 B**		**Number of Samples: TBD[a]**	
Laboratory QC:	**Frequency/ Number**	**Method/SOP QC Acceptable Limits[b]**	**Corrective Action (CA)**	**Person(s) Responsible For CA**	**Data Quality Indicator (DQI)**
Method Blank	1 at beginning, end and every 10 samples	<80% RDL	Invalidate data repeat run	Analyst, Inorganic Supervisor, Quality Control Supervisor	Drift, contamination, method performance
Reagent Blank	1 at beginning of run	None	Look for cause of contamination, qualify data or re-run	None	None
Instrument Blank	NA	None	None	None	None
Matrix Spike Duplicate	1 in 20 samples spiked in duplicate	≤5% RPD	repeat sample or qualify data	analyst, Inorganics supervisor, QAO	precision
Laboratory Matrix Spike	1 in 10 samples spiked	70-130%	repeat sample or qualify data	Analyst, Inorganic Supervisor, Quality Control Supervisor	Matrix interference
Laboratory Control Sample (Independent Calibration Verification) (Ca+Mg)	1 per run	94-108%	Re-cal, Re-run	Analyst, Inorganic Supervisor, Quality Control Supervisor	Accuracy
Laboratory Fortified Blank	1 per run	85-115%	Re-cal, Re-run	Analyst, Inorganic Supervisor, Quality Control Supervisor	Method Performance/ Accuracy
Continuing Calibration Verification	1 every 10 samples	±5% after calibration ±10% after every 10 samples	Re-analyze samples back to last acceptable CCV	Analyst, Inorganic Supervisor, Quality Control Supervisor	Method Performance/ Accuracy

Table 32. Laboratory Analytical QC - NHDES VRAP Program: Copper (Cu)

Analytical Method/SOP Reference: Appendix B-10, B-16		**Measurement Performance Criteria: EPA 200.7; EPA 200.8**		**Number of Samples: TBD[a]**	
Laboratory QC:	**Frequency/ Number**	**Method/SOP QC Acceptable Limits[b]**	**Corrective Action (CA)**	**Person(s) Responsible For CA**	**Data Quality Indicator (DQI)**
Method Blank	1 at beginning, end and every 10 samples	<80% RDL	Invalidate data repeat run	analyst, Inorganics supervisor, QAO	contamination, drift
Reagent Blank	1 at beginning of run	None	Look for cause of contamination, qualify data or re-run	None	None
Instrument Blank	NA	None	None	None	None
Matrix Spike Duplicate	1 in 20 samples spiked in duplicate	≤4% RPD	repeat sample or qualify data	analyst, Inorganics supervisor, QAO	precision
Laboratory Matrix Spike	1 in 10 samples spiked	70-130%	repeat sample or qualify data	analyst, Inorganics supervisor, QAO	matrix effects
Laboratory Control Sample (Independent Calibration Verification) (Ca+Mg)	1 per run	90-107%	Re-cal, Re-run	analyst, Inorganics supervisor, QAO	accuracy
Laboratory Fortified Blank	1 per run	85-115%	Re-cal, Re-run	analyst, Inorganics supervisor, QAO	method performance

[a]to be determined and documented in annual sampling and analysis plans
[b]subject to change annually; changes documented in annual sampling and analysis plans

Table 33. Laboratory Analytical QC - NHDES VRAP Program: Lead (Pb)

Analytical Method/SOP Reference: Appendix B-10, B-16		**Measurement Performance Criteria: EPA 200.7; EPA 200.8**		**Number of Samples: TBD[a]**	
Laboratory QC:	**Frequency/ Number**	**Method/SOP QC Acceptable Limits[b]**	**Corrective Action (CA)**	**Person(s) Responsible For CA**	**Data Quality Indicator (DQI)**
Method Blank	1 at beginning, end and every 10 samples	<80% RDL	Invalidate data repeat run	analyst, Inorganics supervisor, QAO	contamination, drift
Reagent Blank	1 at beginning of run	None	Look for cause of contamination, qualify data or re-run	None	None
Instrument Blank	NA	None	None	None	None
Mareix Spike Duplicate	1 in 20 samples spiked in duplicate	≤5RPD	repeat sample **or** qualify data	analyst, Inorganics supervisor, QAO	precision
Laboratory Matrix Spike	1 in 10 samples spiked	70-130%	repeat sample **or** qualify data	analyst, Inorganics supervisor, QAO	matrix effects
Laboratory Control Sample (Independent Calibration Verification) (Ca+Mg)	1 per run	90-108%	Re-cal, Re-run	analyst, Inorganics supervisor, QAO	accuracy
Laboratory Fortified Blank	1 per run	85-115%	Re-cal, Re-run	analyst, Inorganics supervisor, QAO	method performance

[a]to be determined and documented in annual sampling and analysis plans
[b]subject to change annually; changes documented in annual sampling and analysis plans

Table 34. Laboratory Analytical QC - NHDES VRAP Program: Magnesium (Mg)

Analytical Method/SOP Reference: Appendix B-10		**Measurement Performance Criteria: EPA 200.7 by Spectro Ciros CCD ICP; SM 2340 B**		**Number of Samples: TBD[a]**	
Laboratory QC:	**Frequency/ Number**	**Method/SOP QC Acceptable Limits[b]**	**Corrective Action (CA)**	**Person(s) Responsible For CA**	**Data Quality Indicator (DQI)**
Method Blank	1 at beginning, end and every 10 samples	<80% RDL	Invalidate data repeat run	Analyst, Inorganic Supervisor, Quality Control Supervisor	Method performance contamination drift
Reagent Blank	1 at beginning of run	None	Look for cause of contamination, qualify data or re-run	None	None
Instrument Blank	NA	None	None	None	None
Matrix Spike Duplicate	1 in 20 samples spiked in duplicate	≤5% RPD	repeat sample or qualify data	analyst, Inorganics supervisor, QAO	precision
Laboratory Matrix Spike	1 in 10 samples spiked	70-130%	repeat sample or qualify data	Analyst, Inorganic Supervisor, Quality Control Supervisor	Matrix effects (interference)
Laboratory Control Sample (Independent Calibration Verification) (Ca+Mg)	1 per run	94-110%	Re-cal, Re-run	Analyst, Inorganic Supervisor, Quality Control Supervisor	Accuracy
Laboratory Fortified Blank	1 per run	85-115%	Re-cal, Re-run	Analyst, Inorganic Supervisor, Quality Control Supervisor	Accuracy and methods performance
Continuing Calibration Verification	1 every 10 samples	±5% after calibration ±10% after every 10 samples	Re-analyze samples back to last acceptable CCV	Analyst, Inorganic Supervisor, Quality Control Supervisor	Accuracy and methods performance

[a]to be determined and documented in annual sampling and analysis plans
[b]subject to change annually; changes documented in annual sampling and analysis plans

Table 35. Laboratory Analytical QC - NHDES VRAP Program: Potassium (K)

Analytical Method/SOP Reference: Appendix B-10		**Measurement Performance Criteria: EPA 200.7 by Spectro Ciros CCD ICP; SM 2340 B**		**Number of Samples: TBD[a]**	
Laboratory QC:	**Frequency/ Number**	**Method/SOP QC Acceptable Limits[b]**	**Corrective Action (CA)**	**Person(s) Responsible For CA**	**Data Quality Indicator (DQI)**
Method Blank	1 at beginning, end and every 10 samples	<80% RDL	Invalidate data repeat run	Analyst, Inorganic Supervisor, Quality Control Supervisor	Contamination, method performance, drift
Reagent Blank	1 at beginning of run	None	Look for cause of contamination, qualify data or re-run	None	None
Instrument Blank	NA	None	None	None	None
Matrix Spike Duplicate	1 in 20 samples spiked in duplicate	≤24% RPD	repeat sample or qualify data	analyst, Inorganics supervisor, QAO	precision
Laboratory Matrix Spike	1 in 10 samples spiked	70-130%	repeat sample or qualify data	Analyst, Inorganic Supervisor, Quality Control Supervisor	Matrix /effect
Laboratory Control Sample (Independent Calibration Verification) (Ca+Mg)	1 per run	92-106%	Re-cal, Re-run	Analyst, Inorganic Supervisor, Quality Control Supervisor	Accuracy
Laboratory Fortified Blank	1 per run	85-115%	Re-cal, Re-run	Analyst, Inorganic Supervisor, Quality Control Supervisor	Accuracy and method performance
Continuing Calibration Verification	1 every 10 samples	±5% after calibration ±10% after every 10 samples	Re-analyze samples back to last acceptable CCV	Analyst, Inorganic Supervisor, Quality Control Supervisor	Accuracy and method performance

[a]to be determined and documented in annual sampling and analysis plans
[b]subject to change annually; changes documented in annual sampling and analysis plans

Table 36. Laboratory Analytical QC - NHDES VRAP Program: Sodium (Na)

Analytical Method/SOP Reference: Appendix B-10		**Measurement Performance Criteria: EPA 200.7 by Spectro Ciros CCD ICP; SM 2340 B**		**Number of Samples: TBD[a]**	
Laboratory QC:	**Frequency/ Number**	**Method/SOP QC Acceptable Limits[b]**	**Corrective Action (CA)**	**Person(s) Responsible For CA**	**Data Quality Indicator (DQI)**
Method Blank	1 at beginning, end and every 10 samples	<80% RDL	Invalidate data repeat run	Analyst, Inorganics Supervisor, QAO	Contamination, drift
Reagent Blank	1 at beginning of run	None	Look for cause of contamination, qualify data or re-run	None	None
Instrument Blank	NA	None	None	None	None
Matrix Spike Duplicate	1 in 20 samples spiked in duplicate	≤4% RPD	repeat sample or qualify data	analyst, Inorganics supervisor, QAO	precision
Laboratory Matrix Spike	1 in 10 samples spiked	70-130%	repeat sample or qualify data	Analyst, Inorganics Supervisor, QAO	Matrix effects
Laboratory Control Sample (Independent Calibration Verification) (Ca+Mg)	1 per run	93-110%	Re-cal, Re-run	Analyst, Inorganics Supervisor, QAO	Accuracy
Laboratory Fortified Blank	1 per run	85-115%	Re-cal, Re-run	Analyst, Inorganics Supervisor, QAO	Method performance

[a]to be determined and documented in annual sampling and analysis plans
[b]subject to change annually; changes documented in annual sampling and analysis plans

Table 37. Laboratory Analytical QC - NHDES VRAP Program: Zinc (Zn)

Analytical Method/SOP Reference: Appendix B-10, B-16		**Measurement Performance Criteria: EPA 200.7**		**Number of Samples: TBD[a]**	
Laboratory QC:	**Frequency/ Number**	**Method/SOP QC Acceptable Limits[b]**	**Corrective Action (CA)**	**Person(s) Responsible For CA**	**Data Quality Indicator (DQI)**
Method Blank	1 at beginning, end and every 10 samples	<80% RDL	Invalidate data repeat run	analyst, Inorganics supervisor, QAO	contamination, drift
Reagent Blank	1 at beginning of run	None	Look for cause of contamination, qualify data or re-run	None	None
Instrument Blank	NA	None	None	None	None
Matrix Spike Duplicate	1 in 20 samples spiked in duplicate	≤14% RPD	repeat sample **or** qualify data	analyst, Inorganics supervisor, QAO	precision
Laboratory Matrix Spike	1 in 10 samples spiked	70-130%	repeat sample **or** qualify data	analyst, Inorganics supervisor, QAO	matrix effects
Laboratory Control Sample (Independent Calibration Verification) (Ca+Mg)	1 per run	91-09%	Re-cal, Re-run	analyst, Inorganics supervisor, QAO	accuracy
Laboratory Fortified Blank	1 per run	85-115%	Re-cal, Re-run	analyst, Inorganics supervisor, QAO	method performance

[a]to be determined and documented in annual sampling and analysis plans
[b]subject to change annually; changes documented in annual sampling and analysis plans

Table 38. Laboratory Analytical QC - NHDES VRAP Program: Chlorophyll-a (Chlor-a)

Analytical Method/SOP Reference: Appendix B-17		**Measurement Performance Criteria: No Reference in Standard Methods**		**Number of Samples: TBD[a]**	
Laboratory QC:	**Frequency/ Number**	**Method/SOP QC Acceptable Limits**	**Corrective Action (CA)**	**Person(s) Responsible For CA**	**Data Quality Indicator (DQI)**
Method Blank	10% or weekly	>MDL	Inspect bottles and filtering equipment for contamination	Analyst	Accuracy/Bias (contamination)
Reagent Blank	NA	None	None	None	None
Instrument Blank	One per analytical shift	N/A	Instrument Correction	Instrument	Accuracy/Bias (contamination)
Laboratory Duplicates[c]	10%	±3 µg/L	Review Bench book sample information	Analyst	Analytical Precision
Calibration Verification Check (Turner Low Cal Standard)	Quarterly	±10%	Reanalyze standard	Analyst	Accuracy/Bias
Calibration Verification Check (NIST Test # SRM2031)	Annual	Within Manufacturer's Tolerance(s)	Adjust as required to meet manufacturer's specifications and tolerances	QAQC Officer	Accuracy/Bias

[a]to be determined and documented in annual sampling and analysis plans
[b]subject to change annually; changes documented in annual sampling and analysis plans

Table 39. Laboratory Analytical QC - NHDES VRAP Program: Chloride – Limnology Laboratory

Analytical Method/SOP Reference: Appendix B-17		**Measurement Performance Criteria: ASTM D512(C)**		**Number of Samples: TBD[a]**	
Laboratory QC:	**Frequency/ Number**	**Method/SOP QC Acceptable Limits**	**Corrective Action (CA)**	**Person(s) Responsible For CA**	**Data Quality Indicator (DQI)**
Method Blank	1 per day in conjunction w/ VLAP program	<MDL	Re-cal, Re-run	Analyst	Accuracy/Bias (contamination)
Reagent Blank	1 per day in conjunction w/ VLAP program	<MDL	Re-cal, Re-run	Analyst	None
Laboratory Duplicates[c]	10%	RPD < 10%	Re-run duplicates – qualify data	Analyst	Analytical Precision
Calibration Verification Check	Right after calibration and every 10 samples	100 ±15%	Re-run samples	Analyst	Accuracy/Bias

[a]to be determined and documented in annual sampling and analysis plans
[b]subject to change annually; changes documented in annual sampling and analysis plans

B6 Instrument/Equipment Testing, Inspection, and Maintenance

This section describes the procedures and documentation performed to ensure all field analytical instrumentation and equipment are available and in working order when needed.

All field instruments are visually inspected, calibrated, and tested for accuracy prior to use during the monitoring year, typically in April. Inspection and cleaning also occurs on an as-needed basis, typically before every sampling event, throughout the monitoring year. This includes an inspection of sensors, cables and associated connections to meters, corrosion at cable and/or battery ports, battery power capacity, etc. Any problems identified during the visual inspection are reconciled prior to instrument use. Instruments are subsequently tested according to manufacturer's specifications to ensure proper functionality. Procedures used to test instruments are those used to calibrate the instruments. Any instruments not properly calibrated are re-calibrated according the SOPs. If the second calibration is inadequate, corrective measures shown in Table 40 are employed.

In addition, maintenance log books for the calibration and verification performed by the analysts at the NH DHHS Public Health Laboratory Services, NHDES Limnology Laboratory are kept. These log books also contains a standards log which tracks Lot# and expiration dates.

Table 40. Instrument Equipment Maintenance, Testing, and Inspection

Equipment Name	Activity	Frequency of Activity	Acceptance Criteria	Corrective Action	Person Responsible
Multiprobe dataloggers	Maintenance and Inspection (cleaning); Testing (operation)	~ monthly for long-term deployments. Every deployment for individual ones	Visible cleanliness; consistent w/ data quality objectives in Table 4.	Repeat cleaning. Use alternate datalogger if necessary.	VRAP/WQPS Staff
Water Temperature dataloggers	Maintenance and Inspection (cleaning); Testing (operation)	Annual	Visible cleanliness; consistent w/ data quality objectives in Table 4.	Repeat cleaning. Use alternate datalogger if necessary.	VRAP/WQPS Staff
Water Level dataloggers	Maintenance and Inspection (cleaning); Testing (operation)	Annual	Visible cleanliness; consistent w/ data quality objectives in Table 4.	Repeat cleaning. Use alternate datalogger if necessary.	VRAP/WQPS Staff
Handheld dissolved oxygen meter	Maintenance and Inspection (cleaning,); Testing (operation)	Prior to distribution and prior to each use	Visible cleanliness; consistent w/ data quality objectives in Table 4.	Repeat cleaning. Use alternate meter if necessary.	VRAP/WQPS Staff
Handheld pH meter	Maintenance and Inspection (cleaning, glass bulb inspection); Testing (operation)	Prior to distribution and prior to each use	Visible cleanliness; consistent w/ data quality objectives in Table 4.	Repeat cleaning. Use alternate meter if necessary.	VRAP/WQPS Staff

Equipment Name	Activity	Frequency of Activity	Acceptance Criteria	Corrective Action	Person Responsible
Multiprobe dataloggers	Maintenance and Inspection (cleaning); Testing (operation)	~ monthly for long-term deployments. Every deployment for individual ones	Visible cleanliness; consistent w/ data quality objectives in Table 4.	Repeat cleaning. Use alternate datalogger if necessary.	VRAP/WQPS Staff
Handheld Turbidity meter	Maintenance and Inspection	Prior to distribution and prior to each use	Visible cleanliness; consistent w/ data quality objectives in Table 4.	Repeat cleaning. Use alternate meter if necessary.	VRAP/WQPS Staff
Handheld conductivity meter	Maintenance and Inspection (cleaning); Testing (operation)	Prior to distribution and prior to each use	Visible cleanliness; consistent w/ data quality objectives in Table 4.	Repeat cleaning. Use alternate meter if necessary.	VRAP/WQPS Staff

B7 Instrument Equipment/Calibration and Frequency

All field instruments are calibrated prior to use according to manufacturer's specifications. Calibration methods for all instruments are summarized in Table 41 and documented in detail in Appendix A.

Table 41. Field analytical equipment calibration table

Paramater	Equipment Name	Procedure and SOP Reference (Appendix)	Frequency of Calibration	Acceptance Criteria	Corrective Action
Dissolved Oxygen	YSI Model 85 and 2030; or In Situ and YSI multiprobes:	A-1, A-3, A-5, A-7	Instantaneous readings Prior to each measurement (i.e., if seven measurements are made during the day, the meter is calibrated prior to each of the seven measurements) Deployments Prior to deployment and checked at the end of deployment.	± 0.4 mg/l or ± 2% of calibration saturation, whichever is greater; <0.5 mg/L for the zero DO solution; ≤ 0.5oC for water temperature	Recalibrate. If problem persists, inspect/replace batteries, membrane, and electrolyte. Recalibrate.
pH	Oakton pH 11 and 150; or In Situ and YSI multiprobes	A-1, A-3, A-5, A-7	Instantaneous readings Prior to each measurement	Slope value 95-105%; ± 0.3 standard units	Recalibrate. If problem persists, inspect/replace batteries,

			Deployments Prior to deployment and checked at the end of deployment.		replace buffers, and ensure electrode is appropriately filled with filling solution. Recalibrate.
Specific Conductance	YSI Model 85 and 2030: or Onset, In Situ and YSI multiprobes	A-1, A-3, A-5, A-7, A-11	Instantaneous readings Prior to each measurement Deployments Prior to deployment and checked at the end of deployment.	± 20% of calibration standard	Turn off. Inspect/replace batteries. Turn on.
Turbidity	LaMotte Model 2020, 2020e, and 2020 we; or In Situ and YSI multiprobes	A- A-1, A-3, A-5, A-7	Instantaneous readings Prior to each measurement Deployments Prior to deployment and checked at the end of deployment.	± 1.0 NTU	Recalibrate. If problem persists, inspect/replace batteries and standard solutions. Recalibrate.
Water Temperature	Onset WaterTemp Pro Water Temperature Dataloggers	A-9	Datalogger are factory calibrated. Precision check done annually in laboratory with NIST thermometer.	± 0.3 °C.	If problems persist contact manufacturer and use alternative dataloggers.
Water Level	Onset Water Level/Barometric Pressure Dataloggers	A-12	Datalogger are factory calibrated. Measurements are checked for continuity with previous datasets and with discharge rating curve.	NA	If problems persist contact manufacturer and use alternative dataloggers.
Velocity	Marsh McBirney Flow Meter	A-10	Meter is zero checked prior to each use and recalibrated as needed.	± 0.05 ft/s	Recalibrate. If problem persists, inspect/replace batteries.

B8 Inspection/Acceptance Requirements for Supplies and Consumables

VRAP uses minimal field equipment for water sampling, whereas multiple instruments are used for analytical tasks (Table 42). Typical VRAP sampling equipment includes water sample bottles, bucket, surveyor's tape measure, surveyor's rope, padlocks, keys, various lengths of cable, and cinder blocks.

VRAP staff and the Laboratory QA Manager examine the supplies and water sample bottles prior to use. Additional supplies and water sample bottles accompany the volunteers during sample collection in the event of contamination or damage to water sample bottles.

All calibration reagents will be visually inspected for expiration dates, discoloration, or other indicators of poor quality or contamination by VRAP staff prior to distribution to volunteers. Similarly, volunteers will inspect all equipment, supplies, and calibration reagents prior to initiating sampling.

Table 42. Field Sampling Equipment Maintenance, Testing, and Inspection

Equipment name	Activity	Frequency of Activity	Acceptance Criteria	Corrective Action	Person Responsible
Nutrient, bacteria, metals, etc. water sample bottles	Maintenance (cleaning); Inspection	As necessary, prior to use	No visible internal contamination or external damage	If found contaminated or damaged prior to sampling, do not use. Use alternate sample container.	Laboratory QA Manager
Sampling bucket	Maintenance (cleaning); Inspection	As necessary, prior to use	No visible internal contamination or external damage	If found contaminated or damaged prior to sampling, do not use. Use alternate sample container.	Volunteers; Program Manager
Surveyor's tape measure; Surveyor's rope	Maintenance (cleaning); Inspection	As necessary, prior to use	No visible damage	If found damaged or illegible prior to sampling, do not use. Use alternate tape measure.	Volunteers; Program Manager
Various lengths of cable	Maintenance; Inspection	As necessary, prior to use	No visible damage	If found damaged prior to sampling, do not use. Use alternate cable.	Interns; Program Manager
Padlocks	Maintenance; Inspection	As necessary, prior to use	No visible damage	If found damaged prior to sampling, do not use. Use alternate cable.	Interns; Program Manager

B9 Non-Direct Measurements

VRAP is typically designed to fill data gaps identified through previous VRAP sampling and other NHDES programs. Other programs include, but are not necessarily limited to the Trend, Synoptic and Ambient River Monitoring Programs, Volunteer Lake Assessment Program (VLAP), Section 401 Water Quality Certification, and Total Maximum Daily Load Studies (Table 43). In addition, responses to public complaints often generate data for which are used to identify VRAP sampling stations for any given year. Ancillary information is also derived from photographs, topographic maps, and Geographic Information System (GIS) thematic layers. It is important to note GIS information is used for reference only.

Table 43. Non-Direct Measurements Criteria and Limitations Table

Non-direct measurement (secondary data)	Data source, report date, data generator, data collection dates	How data will be used	Limitations on data use
Water Quality Data	Ambient/Trend/Synoptic Monitoring Programs (1990-present)	Determine need for additional sampling and/or sampling stations	Requires validation by NHDES for use in 303(d) list and 305(b) report preparation
Water Quality Data	Volunteer Lake Assessment Program (1988-present)	Determine need for additional sampling and/or sampling stations	Requires validation by NHDES for use in 303(d) list and 305(b) report preparation
Water Quality Data	Section 401 Water Quality Certification Program (1992-present)	Determine need for additional sampling and/or sampling stations	Requires validation by NHDES for use in 303(d) list and 305(b) report preparation
Water Quality Data	Total Maximum Daily Load Program (2001-present):	Determine need for additional sampling and/or sampling stations	Requires validation by NHDES for use in 303(d) list and 305(b) report preparation
Water Quality Data	Responses from public complaints (1998-present)	Determine need for additional sampling and/or sampling stations	Requires validation by NHDES for use in 303(d) list and 305(b) report preparation

B10 Data Management

B10.1 Data Tracking and Management

Field measurement data are recorded on field data sheets and subsequently retained in individual folders for each VRAP group participating in a given year. Throughout the monitoring period, field measurement data are entered in the EMD after review by VRAP staff. If laboratory results are not associated with the field measurement data, the field data are entered manually into the NHDES EMD. In such case, field measurements are assigned a permanent unique activity identification number at the time of data entry. The activity identification number represents the batch of field measurements (e.g., water temperature, dissolved oxygen concentration, pH, etc.) made at a particular sampling station on a particular day. All data entered in the EMD are cross-checked against the data on the field data sheets by a second staff member to eliminate data entry errors; data entry errors are immediately corrected. A copy of the field data sheet is given in Appendix A-2.

Laboratory results are hand-written in bench books at the time of analysis. The results are subsequently entered in the LIMS database or Limnology Center database by laboratory personnel. Results are transmitted electronically through the EMD and on paper via Intra-department mail to the Program Manager. A Watershed Management Bureau data analyst notifies the Program Manager of success or failure of data uploaded to the EMD. After all laboratory data are uploaded from the laboratory databases, any corresponding field data are manually entered and associated with the laboratory data through the unique activity identification number. The activity identification number represents the batch of laboratory results and field measurements (e.g., total phosphorus, ammonia, water temperature, dissolved oxygen concentration, pH, etc.) collected from and made at a particular sampling station on a particular day.

All data are entered, processed, and analyzed using personal computers that support the Microsoft (MS) suite of software programs. The EMD is maintained on the NHDES computer network and is secured through daily back-up procedures. Charts, tables, figures, and descriptive statistics (e.g., mean,

maximum, minimum, etc.) are generated, as necessary, using MS Excel software. Raw data are extracted from the EMD to support the development of the 303(d) list and 305(b) report

B10.2 Data Tracking and Control

All data are tracked by VRAP staff and laboratory personnel. The field data sheets are examined by VRAP staff upon arrival at NHDES. Results from laboratory analyses are transferred to bench books, and, subsequently, to the LIMS and Limnology Center databases by laboratory personnel. The results are relinquished to the Program Manager after automatic upload to the EMD. Paper copies from the LIMS are also transmitted to the Program Manager. The field data sheets and laboratory results sheets are retained in the Water Quality Planning Section office. All data remain secure in the LIMS, Limnology Center database, and EMD, which are maintained on the NHDES computer network. Access to the computer network is restricted to NHDES staff. Data are retrieved through the use of the query options provided by the database software.

C. ASSESSMENT AND OVERSIGHT

C1 Assessment and Oversight

C1.1 Assessments and Response Actions

VRAP supports water quality monitoring programs of numerous volunteer groups throughout the state. Therefore, field audits are encouraged to ensure data quality (Table 44). The audits are conducted on the individual volunteer groups during the sampling period for water sample collection, calibration and operation of instrumentation, QA/QC procedures, and data documentation. During the field audits a VRAP staff member accompanies the volunteer monitors in the field during water sampling. Due to time limitations during the sampling season the Program Manager may determine that a field audit is unnecessary for a VRAP group that in past years has passed all field audits. VRAP volunteers fill out self-audit checklists during sampling events to ensure that all QA/QC procedures are followed (Appendix C-6)

A formal audit for data entry is conducted twice each year, according to the data entry schedule, where the Program Manager or QA Officer oversees the VRAP intern as data are input to the database.

Planned assessments are not conducted in the NH DHHS Public Health Laboratory for data collected specifically for VRAP. However, proficiency testing, replicate testing, and re-testing of retained samples are among the attributes of the laboratory performance audits that are conducted throughout the year. Assessments by other laboratories are documented in annual SAPs developed by the individual volunteer groups and VRAP staff; the SAPs are retained at the Water Quality Planning Section office.

Quality Assurance System Program Self-Audits are conducted annually for the general operation of VRAP, pursuant to the NHDES Quality Management Plan (QMP). These assessments document the deviations, if any, between the operation of VRAP during any particular year, and the consistency with the approved QAPP.

Table 44. Project Assessment Table

Assessment Type	Frequency	Person(s) responsible for performing assessment, title and organizational affiliation	Person(s) responsible for responding to assessment findings, title and organizational affiliation	Person (s) responsible for identifying and implementing corrective actions (CA), title and organizational affiliation	Person (s) responsible for monitoring effectiveness of CA, title and organizational affiliation
Field Sampling Audit (review of volunteer monitoring sampling performance)	Minimum of once during the sampling period	VRAP staff: NHDES	VRAP staff: NHDES	VRAP staff: NHDES	VRAP staff: NHDES
Field Sampling Audit (review of VRAP and other WPQS interns assigned to VRAP program)	A least twice at the beginning of the season prior to sampling on own with volunteer monitors	Program Manager or QA Officer: VRAP NHDES	Program Manager or QA Officer: VRAP NHDES	Program Manager or QA Officer: VRAP NHDES	Program Manager or QA Officer: VRAP NHDES
Limnology Center Fixed Laboratory Audit	Weekly	Scott Ashley QA/QC Officer NHDES	Scott Ashley QA/QC Officer NHDES	Scott Ashley QA/QC Officer NHDES	Scott Ashley QA/QC Officer NHDES
Satellite Laboratory Fixed Laboratory Audit	Annual	Internal	NHDES	Scott Ashley QA/QC Officer NHDES	Scott Ashley QA/QC Officer NHDES
NH DHHS Public Health Laboratory Services Fixed Laboratory Audit	Annually in September	Rachael Rainey NH DHHS Public Health Laboratory QA/QC Officer NHDES	Rachael Rainey NHDES Lab QA/QC Officer NHDES	Rachael Rainey NH DHHS Public Health Laboratory QA/QC Officer NHDES	Rachael Rainey NH DHHS Public Health Laboratory QA/QC Officer NHDES
NHDES Program Self-Audit	Annually during fall of any given year	Program Manager or QA Officer	Program Manager or QA Officer	Program Manager or QA Officer	Vincent Perelli NHDES Quality Assurance Manager

C1.2 Assessment Findings and Corrective Action Responses

Following the completion of field audits, VRAP staff identifies any inconsistencies between the QAPP and the actual performance of methods outlined in this QAPP and associated SOPs. VRAP staff will

determine the magnitude of the inconsistencies, and determine the potential for substantive error generated by the inconsistencies. Subsequently, a decision is made to either conditionally retain the data or flag the data as invalid in the EMD and thus remove the data from being used for water quality assessments. VRAP staff also determines whether the QAPP and/or SOPs should be revised due to inefficiency, or whether volunteer monitors require additional training.

Following the completion of laboratory audits, the laboratory QA/QC officer identifies discrepancies related to the analytical procedures are recorded on the bench log or data package. The laboratory QA/QC Officer subsequently reviews the bench logs, data package, and Corrective Action forms, and electronically retains Corrective Action forms.

C1.3 Additional QAPP Non-Conformances

Corrective actions will be implemented any time deviations or errors are noted in field and laboratory work during the project.

C2 Reports to Management

Routine Quality Assurance (QA) Management Reports are not written for VRAP, although an annual QA memorandum is written at the conclusion of the data collection period. This memorandum summarizes the QA activities conducted during that particular year, including

- Summary of QA/QC objectives;
- Description of training activities;
- Conformance to QAPP requirements/procedures, and descriptions of deviations, if any, from the approved QAPP and approved amendments, if any, to the QAPP;
- Limitations of data;
- Documentation of usable data versus amount of data actually collected;
- List of reasons why data are not usable. This includes a review of any of the following
    - Precision
    - Accuracy
    - Representativeness
    - Completeness
    - Comparability
    - Sensitivity
- Summary of conflicts, and subsequent resolution of conflicts, associated with sampling; and
- Use and effectiveness of corrective actions, if corrective actions were taken.

Copies of the memorandum are retained in the VRAP files for reference when preparing the 303(d) list and 305(b) report. Copies are also transmitted to the NHDES Quality Assurance Manager. VRAP data are consistently reviewed during the sampling period to determine sampling efficiency.

Quality Assurance System Program Self-Audits are conducted annually for the general operation of VRAP, pursuant to Chapter 9 and Chapter 10 of the NHDES Quality Management Plan (QMP). These assessments document the deviations, if any, between the operation of VRAP during any particular year,

and the consistency with the approved QAPP. The results of the self-audits are transmitted to the NHDES QA Manager.

Though frequent QA management reports will not be generated, frequent review of VRAP data (as described in Section C-1) will be conducted to determine sample efficiency. In addition, information is provided to each VRAP group in their annual report documenting any QA issues and flagging data that has been deemed invalid for water quality assessments.

D. DATA VALIDATION AND USEABIILITY

D1 Data Review, Verification, and Validation

VRAP supports water quality monitoring programs of numerous volunteer groups throughout the state, where the data are used to (1) generate water quality reports for the individual volunteer groups, and (2) support the development of the 303(d) list and 305(b) report. Therefore, data verification and validation are required for ensuring data quality. All field data, laboratory data, and appurtenant documentation are verified and validated prior to use in water quality reports and surface water quality assessments. However, verification and validation need not be conducted by external entities. The field data collection and field and laboratory data entry activities associated with VRAP are subject to verification and validation reviews by VRAP staff, whereas the analytical procedures performed in the laboratory are verified and validated by the Laboratory QA Manager.

D2 Verification and Validation Procedures

Throughout the monitoring period, VRAP staff verify the data following data collection, often on a daily basis (Table 45). The data are also verified through field audits described in Section C1.1 of this QAPP, which includes proper documentation of field instrument calibration data, documentation of data collected during sampling, and appropriate reconciliation of documentation errors during calibration and field activities. A copy of the field audit checklist is provided in Appendix C-6. At the conclusion of the monitoring period, verification reviews are conducted by the Program Manager to ensure consistency between laboratory samples submitted and laboratory data received.

In addition, VRAP volunteers are instructed to conduct their own data review/validation in the field and before submitting the field data sheets to NHDES. If VRAP participants feel that data on the field data sheets if questionable they are asked to make note of it and NHDES will usually invalidate the data based on the judgment of the trained volunteers.

Verification reviews for laboratory-based activities, including transfer of sample custody, are documented in the NH DHHS Public Health Laboratory Quality Systems Manual (QSM).

Table 45. Data Verification Process

Verification Task	Description	Person Responsible for Verification (Name, Organization)
Sampling Design	Conformance to the sampling design is verified as soon as possible after sampling. This includes a comparison of the daily sampling plan against the sampling that actually occurred. Any inconsistencies are discussed and reconciled	Program Manager/QA Officer NHDES

Verification Task	Description	Person Responsible for Verification (Name, Organization)
	prior to the subsequent sampling day if the subsequent sampling day is impacted by the inconsistency.	
Field Instrumentation Calibration	Calibration data for each field instrument are verified as soon as possible after sampling, according to the respective SOPs. Completeness is the primary concern. The verification review ensures all calibration data have been recorded prior to data collection. Requisite corrective actions are imposed immediately after error identification.	VRAP Volunteers VRAP Staff NHDES
Field Data Sheets	Field data are verified according to this QAPP; completeness and adherence to error reconciliation procedures are the primary concerns. The verification review is conducted as soon as possible after sampling to ensure field data are appropriately documented on the field data sheets and documentation errors are properly reconciled. Requisite corrective actions are imposed immediately after error identification.	VRAP Volunters VRAP Staff NHDES
Sample Handling	The transfer of custody of each water sample is verified as part of the consistency determination conducted for Laboratory Analysis, and is described, below.	VRAP Volunteers VRAP Staff NHDES
Laboratory Analysis	Laboratory data packages are verified internally for completeness prior to transmittal, in accordance with the NH DHHS Public Health Laboratory QSM. Verification also includes a consistency determination to ensure the laboratory transmits results of all samples submitted during the monitoring period.	Laboratory QA Manager NHDES VRAP Staff NHDES

D3 Validation

The VRAP program requires individual validation events by the VRAP staff throughout the monitoring period.

D3.1 Field Data

Validation reviews for field-generated data are conducted as soon as possible after each sampling day or after the data is received by VRAP staff from the volunteer monitors. VRAP staff review calibration data and field sampling data (dissolved oxygen, temperature, pH, specific conductance, turbidity) to ensure data are within the anticipated limits (*e.g.*, pH values must not exceed 14 standard units). VRAP staff screen the data and discusses any potential outliers with the volunteer monitors. VRAP staff validate or invalidate the data collected for a particular sampling day as soon as possible after the data is received at NHDES.

D3.2 Laboratory Data

Validation reviews for laboratory-generated data are conducted by the NH DHHS Public Health Laboratory staff under the supervision of the Laboratory QA Manager. In addition, a validation review by VRAP staff is conducted for any potential outliers following transmittal of laboratory data. The

Program Manager contacts the Laboratory QA Manager to reconcile any inaccuracies. During and after the conclusion of the monitoring season, the Program Manager authorizes other NHDES Watershed Management Bureau staff to input data to the EMD.

D4 Reconciliation with User Requirements

D4.1 Data Review

The usability of validated project data is determined through statistical calculations and numerical comparisons with the measurement performance criteria and project quality objectives discussed in Section A-7 of this QAPP. The usability assessment is conducted after the conclusion of the monitoring period to consider the overall performance of the monitoring effort. VRAP staff conduct the assessment based on the measures described, below. All data that exceed the limits defined by the individual measures are flagged accordingly in the EMD.

Precision: As discussed in Section A7.1, replicate sample/measurement results are paired with the corresponding original field sample/measurement results. The pairs are used to calculate data precision. The calculations are made after the conclusion of the sampling season, according to equation 1, below. The calculations are compared with the analytical ranges and RPD values defined in Table 4 of Section A7.1 to determine whether data are valid or invalid. Data will be marked invalid in the EMD if RPDs are exceeded.

(1)
$$RPD = \frac{|x_1 - x_2|}{\frac{x_1 + x_2}{2}} \times 100\%$$

where x_1 is the original sample concentration
x_2 is the replicate sample concentration

Accuracy/Bias: Field and laboratory-derived data are subject to comparison with field equipment blank sample, laboratory fortified matrix samples, and initial calibration values throughout the monitoring period. Results from these samples are compared with the accuracy limits defined in Table 4 of Section A7.1. Results that exceed the limits will be marked invalid in the EMD.

Sample Representativeness: Field and laboratory data are reviewed relative to the original sampling design. Field sampling audits are used to document representativeness.

Sensitivity and quantitation limits: All field and laboratory data are reviewed relative to the prescribed limits defined in Section A-7 of this QAPP.

Completeness: Data collected by the VRAP program is voluntary and thus any amount of valid data collected is useable for making assessments. However, the goal is to collect at least 75% of the data scheduled by an individual VRAP group's annual Sampling and Analysis Plan.

Comparability: All field and laboratory-derived data are assumed comparable unless otherwise determined by the Program Manager and/or NH DHHS Public Health Laboratory QA Manager. This assumption is based on the use of consistent field sampling and field analytical procedures, and consistent laboratory analytical procedures. Any procedural or protocol deviations are reported to VRAP staff by the volunteer monitors or the Laboratory QA Manager.

D4.2 Data Limitation and Actions

Any data that exceed the limits of the individual measures, above, are flagged in the EMD and may be disqualified from surface water quality assessments. These flagged data may be used to guide future monitoring efforts. VRAP staff review all exceedences and determines the need for revisions to the sampling and/or analytical methods. If the cause of data failure is found to be sampling error, volunteers will be contacted and retrained.

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